

**OBSOLETE**

# **TM 9-744**

**WAR DEPARTMENT TECHNICAL MANUAL**

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**ORDFQ - S. C. - EQUIP**

**155-mm HOWITZER**

**MOTOR CARRIAGE**

**M41**

# 155-mm HOWITZER MOTOR CARRIAGE M41



WAR DEPARTMENT • SEPTEMBER 1947

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**WAR DEPARTMENT**  
**WASHINGTON 25, D. C., 17 September 1947**

TM 9-744, 155-mm Howitzer Motor Carriage, M41, is published for the information and guidance of all concerned.

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**BY ORDER OF THE SECRETARY OF WAR:**

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## PART ONE

# INTRODUCTION

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### Section I. GENERAL

#### 1. Scope

a. These instructions are published for the information and guidance of all concerned. They contain information on operation and maintenance of the equipment as well as descriptions of the major units and their functions in relation to other components of this vehicle. They apply only to the 155-mm howitzer motor carriage M41 and are arranged in four parts: Part One, Introduction; Part Two, Operating Instructions; Part Three, Maintenance Instructions; Part Four, Auxiliary Equipment and Appendix.

b. The appendix at the end of the manual contains instructions for shipment and limited storage, and a list of references including standard nomenclature lists, Technical Manuals, and other publications applicable to the vehicle.

#### 2. Records

a. GENERAL. Forms, records, and reports are designed to serve necessary and useful purposes. Responsibility for the proper execution of these forms rests upon commanding officers of all units operating and maintaining vehicles. It is emphasized, however, that forms, records, and reports are merely aids. They are not a substitute for thorough practical work, physical inspection, and active supervision.

b. AUTHORIZED FORMS. The forms, records, and reports generally applicable to units operating and maintaining these vehicles are listed below with brief explanations of each. Only approved War Department forms will be used in operating and maintaining the vehicles. Pending availability of forms listed, old forms may be used. For a current and complete listing of all forms, see current FM 21-6.

(1) *War Department Lubrication Order.* War Department Lubrication Order No. LO 9-744 prescribes lubrication maintenance for this vehicle. A lubrication order is issued with each vehicle and will be carried with it at all times. Instructions contained therein

are mandatory to all users of the equipment and supersede all conflicting lubrication instructions of prior date.

(2) *Standard Form 26 (Driver's Report—Accident, Motor Transportation)*. One copy of this form will be kept with vehicle at all times. In case of an accident resulting in injury or property damage, it will be filled out by the driver on the spot or as promptly as practicable thereafter.

(3) *War Department Form 30 (Report of Claims Officer)*. This form will be used by the claims officer in reporting his investigation of vehicle accidents.

(4) *War Department Form 48 (Driver's Trip Ticket and Preventive Maintenance Service Record)*. This form, properly executed, will be furnished driver or operator when his vehicle is dispatched on non-tactical missions. The driver and the official user of the vehicle will complete in detail appropriate parts of this form. This form need not be issued for vehicles in convoy or on tactical missions. The reverse side of this form contains the driver's daily and weekly preventive maintenance service schedule, the accomplishment of which is mandatory.

(5) *War Department AGO Form 9-69 (Spot Check Inspection Report for All Full-Track and Tank-Like Wheeled Vehicles)*. This form is provided as a record for use by commanders and their staff representatives conducting command inspections on this type of equipment.

(6) *War Department AGO Form 9-71 (Locator and Inventory Control Card)*. Except when specified otherwise by the War Department, this form will be used as a bin tag, locator card, or inventory control card by all units authorized automotive spare parts.

(7) *War Department AGO Form 9-73 (Data for Registration)*. All vehicles will be registered in the War Department Motor Vehicle Central Records Office; Office, Chief of Ordnance, Washington 25, D. C. Attn:ORDFQ. Registration will be made by accomplishing this form in accordance with AR 850-10.

(8) *War Department AGO Form 9-74 (Motor Vehicle Operator's Permit)*. This form will be issued by commanders to all operators of vehicles who are qualified to operate the particular vehicles noted on the permit.

(9) *War Department AGO Form 9-75 (Daily Dispatching Record of Motor Vehicles)*. This form will be used to keep a daily record of all vehicles dispatched.

(10) *War Department AGO Form 9-76 (Request for Work Order)*. This form will be used for requesting repairs, alterations, or other type of work within or between organizations and departments.

(11) *War Department AGO Form 9-77 (Job Order Register)*. This form will be used to keep a chronological record of work orders.

(12) *War Department AGO Form 13-1 (Automotive Disability Report of Vehicles Disabled More Than Three Days)*. This form will be accomplished and submitted as directed in current War Department instructions.

(13) *War Department AGO Form 460 (Preventive Maintenance Roster)*. This form will be used for scheduling and maintaining a record of motor vehicle maintenance operations (weekly, monthly, quarterly, and semiannually).

(14) *War Department AGO Form 462 (Work Sheet for Full-track and Tank-Like Wheeled Vehicles)*. This form will be used for maintenance services and for all technical inspections of these vehicles.

(15) *War Department AGO Form 478 (Modification Work Order and Major Unit Assembly Replacement Record and Organization Equipment File)*. This form will be kept in possession of second echelon personnel and will accompany vehicles upon transfer and evacuation to higher echelon. It will be a record of all modifications made and exchanges of major unit assemblies. Minor repairs, parts, and accessory replacements will not be recorded. In the field, where no filing facilities are available, this form will be kept in a filing jacket.

(16) *War Department AGO Form 441 (Monthly Motor Vehicle Accident Summary Report)*. This form will be used to furnish a monthly summary of accidents involving vehicles.

(17) *War Department AGO Form 811 (Work Request and Job Order)*. This form will be used by organizational maintenance units when requesting repair by a higher echelon repair unit.

## **Section II. DESCRIPTION AND DATA**

### **3. Description**

*a. GENERAL.* The 155-mm howitzer motor carriage, M41, is an armored, full-track laying, self-propelled mount for a 155-mm howitzer. It carries 5 of the 12 men who comprise the crew. Of the 5 men carried, 2 travel in the driving compartment and 3 in seats on the gun mount. The vehicle is designed with a driving compartment at the front, an engine compartment in the center, and a fighting compartment at the rear, above which the howitzer mount is assembled. Dual controls are provided for the driver and for emergency operation of the vehicle by the assistant driver.

*b. POWER TRAIN.* The vehicle is driven by two Cadillac, 8-cylinder, 90°, V-type, liquid-cooled engines, through two hydramatic transmissions; a transfer unit with mechanically selected speed ranges, two forward and one reverse; a controlled differential for steering and braking, which is located in the front of the hull; two final drives; and the necessary connecting propeller shafts. Wide steel block tracks provide the means of propulsion. Torsion arm suspension is used for

the dual track wheels, and includes a compensating wheel at the rear on each side to keep track tension more nearly uniform on rough terrain.

**c. HULL.** The hull of this vehicle is a completely welded structure, except for portions of the front, top, and floor, which are removable for service operations. The hull is divided into three compartments: The driving compartment at the front, the engine compartment in the center, and the fighting compartment at the rear, above which is mounted the 155-mm howitzer. The driving and engine compartments are separated by a bulkhead that extends from side-to-side, and from the roof down to the bulkhead extensions, which in turn extend forward far enough to cover the transfer unit. The engine and stowage compartments are separated by a bulkhead that extends from side-to-side and from roof-to-floor. A spade and gunner's platform assembly is hinged to brackets mounted on the hull at the rear of the vehicle. When the spade and platform assembly is in the raised position it serves as a tailgate. The spade and platform assembly in the lowered position provides a platform for the gunner and the spade acts as an anchor to keep the vehicle in position when the gun is fired. The spade assembly is raised and lowered by a hand operated winch. The front of the hull slopes downward at the top and upward at the bottom to form a V. The sides of the hull slope inward at the bottom. Lifting eyes are provided and should always be used when the vehicle is to be lifted.

**d. HOWITZER.** The howitzer, mount, and shielding are mounted at the rear of the vehicle. The mount provides 5° depression, 45° elevation, 20½° right traverse and 17° left traverse.

## 4. Tabulated Data

### a. GENERAL.

Purpose-----	Mobile artillery.
Type-----	Full-track laying.
Crew-----	12 men.
Weight (with fuel, ammunition, and crew)-----	42,500 lb.
Length-----	230 in.
Width-----	112 in.
Height, over-all-----	96 in.
Ground clearance-----	17¾ in.
Ground pressure at 1-inch penetration-----	8.816 psi.

### b. MAXIMUM OPERATING CHARACTERISTICS.

Sustained speed-----	30 mph.
Grade, ascending or descending-----	60 pct.
Width of ditch-----	9 ft.
Vertical obstacle-----	40 in.
Fording depth-----	42 in.

Hull floor:

Ahead of second pair of torsion springs-----  $\frac{1}{2}$  in.  
Behind second pair of torsion springs-----  $\frac{3}{8}$  in.  
Hull rear (tailgate thickness)-----  $\frac{1}{4}$  in.

*h.* ELECTRIC SYSTEM.

Voltage----- 24.  
Batteries----- 2, (comprising two 6-cell  
units in series).  
Battery locations----- 1, each side of vehicle  
engine compartment.  
Battery master switch----- On bulkhead just behind  
driver's seat.

*i.* COMMUNICATIONS.

Radio----- SCR 619 or SCR 610 or  
BR 19 (24 volt).  
Interphone RC99----- 3 stations.  
Other----- Signal flags, flares, iden-  
tification panels.

## **PART TWO**

### **OPERATING INSTRUCTIONS**

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#### **Section III. GENERAL**

##### **5. Scope**

Part Two contains information for the guidance of the personnel responsible for the operation of the equipment. It contains information on the operation of the equipment, with a description and location of controls and instruments.

#### **Section IV. SERVICE UPON RECEIPT OF EQUIPMENT**

##### **6: Purpose**

*a.* When a new or reconditioned vehicle is first received by the using organization, it is necessary for battery maintenance personnel to determine whether or not the vehicle has been properly prepared for service by the supplying organization, and to be sure it is in condition to perform any mission to which it may be assigned when placed in service. For this purpose, inspect all assemblies, subassemblies, and accessories to be sure they are properly assembled, secure, clean, and correctly adjusted and/or lubricated. Check all tools and equipment to be sure every item is present, in good condition, clean, and properly mounted or stowed.

*b.* In addition, the using organization will perform a run-in test of at least 50 miles on all vehicles as directed in AR 850-15, according to procedures in paragraph 8 herein.

*c.* Whenever practicable, the first echelon personnel crew will assist in the performance of these services.

##### **7. Correction of Deficiencies**

Deficiencies disclosed during the course of these services will be treated as follows:

*a.* Correct any deficiencies within the scope of the maintenance echelons of the using organization before the vehicle is placed in service.

*b.* Refer deficiencies beyond the scope of organizational maintenance to Ordnance maintenance personnel for correction.

c. Bring deficiencies of a serious nature to the attention of the supplying organization through proper channels.

## 8. Specific Procedures

a. **PRELIMINARY SERVICE.** Before the vehicle is moved to make actual run-in test, certain inspections and services will be performed as follows:

b. **INSPECTIONS AND SERVICES** (1) *Fire extinguishers.* See that the portable- and fixed-system cylinders are securely stowed. Inspect the operating valves. If the valves appear to have been opened or damaged, report to proper authorities for exchange or refill. Examine the lines, nozzles, and control cables of the fixed system to see that they are in good condition and that the nozzles are not clogged.

(2) *Fuel, oil, and water.* Fill fuel tanks. Check level of coolant in radiator and add as necessary to bring to correct level. Allow room for expansion in fuel tanks and radiators. During freezing weather, test strength of antifreeze and add as necessary to protect system against freezing. Check level of oil in each engine. **Caution:** If there is a tag attached to the crankcase filled caps concerning engine oil in crankcases, follow instructions on tags before driving vehicle.

*Note.* Vehicles shipped from depots may have white unleaded gasoline in the tanks. This should be drained and 80 octane used for filling.

(3) *Fuel strainer.* Inspect the fuel strainer at each carburetor inlet elbow for leaks or damage. Remove strained bowl and clean out any accumulation of foreign matter. Be sure that both fuel switches and shut-off valves operate properly. Drain accumulated dirt and water from bottom of fuel tanks. Drain only until fuel runs clean.

(4) *Batteries.* Remove battery covers and clean any accumulated dust or dirt from tops of batteries. Make hydrometer and voltage test of batteries and if necessary, add distilled or clean water to bring electrolyte to  $\frac{1}{2}$  inch above plates.

(5) *Air cleaners and breathers.* Examine carburetor air cleaners and crankcase breather cleaners to see that they are in good condition and secure. Remove air-cleaner elements, wash in dry-cleaning solvent, and fill reservoirs with oil to the correct level as directed in lubrication order (par. 32). Reinstall securely, and make sure all connections are in good condition and ducts and air-horn connections are tight.

(6) *Accessories and belts.* See that accessories such as carburetor, generators, regulators, distributors, starters, water pumps, and fans on both engines are securely mounted and that drive belts are in good condition and adjusted with  $\frac{5}{8}$ - to  $\frac{3}{4}$ -inch, finger-pressure deflection (fig. 50).



(7) *Electrical wiring.* Inspect all accessible wiring and conduits to see that these parts are in good condition, securely connected and properly supported.

(8) *Tracks.* Clean all foreign material from tracks and suspension units. Examine track blocks for damage and for loose or damaged nuts and screws. See that tracks are correctly assembled and mounted and that tension is adjusted so that there is  $\frac{3}{4}$ - to 1-inch sag between the second and third support rollers (fig. 128).

(9) *Wheel and flange nuts.* See that operating compensating wheel, track wheel, sprocket, and support roller assembly mounting and flange nuts are present and secure.

(10) *Fenders and shields.* See that fender brush guards and sand-shields (if so equipped) are in good condition and secure and that shield hinges operate properly.

(11) *Towing connections.* Examine towing loops, pintles, and gun traveling lock for looseness and damage. Be sure that pintle hook and gun traveling lock operate properly and lock securely.

(12) *Hull and tarpaulin.* See that all hull attachments, hardware, lift loops, doors and their releases and locking mechanisms, are in good condition, secure, and operating properly. Examine all hull and gun mount attachments for looseness and damage. Be sure hull drain valves open and close freely. Inspect tarpaulin or camouflage net to see that these items are in good condition, and mount or stow them securely. Make sure there are no bright spots to cause glare, and that all markings are legible.

(13) *Vision devices.* Inspect periscope prisms and windows (mounted or spares) to see that they are in good condition and clean. See that mounted units are secure in holders, and that holders are properly mounted. Test each periscope to be sure it will elevate, traverse, and depress through full range.

**Caution:** Clean periscope only with a soft cloth or brush.

(14) *Lubrication.* Perform a complete lubrication of the vehicle, covering all intervals according to instructions in the lubrication order except gear cases and units lubricated or serviced in items (1) to (13). Check all gear case oil levels and add as necessary to bring to correct levels; change only if condition of oil indicates the necessity, or if oil is not of proper grade for existing atmospheric temperature.

*Note.* Perform items (15) to (18) during lubrication.

(15) *Suspensions.* Examine all suspension arms, brackets, shock absorber links, and guides to see if they are in good condition, correctly assembled, secure, and not leaking excessively at seals. Inspect sprocket teeth for damage or excessive wear. Be sure road wheel and support roller tires are in good condition and that rubber is not separating from rims. While applying lubrication, examine seals for excessive leaks.

(16) *Steering linkage.* Inspect all shafts, arms, rods, connections, levers, and grips to see if they are in good condition, correctly and securely assembled and mounted, and that they operate without excessive looseness or binding. Check brake linkage adjustment by pulling back evenly to make sure free travel is equal and does not exceed six notches, and that brakes are fully applied within three additional notches (par. 134). Be sure parking brake mechanism locks the brake properly in the locking position.

(17) *Propeller shafts.* Remove all propeller shaft covers, and inspect shafts and universal joints to see if they are in good condition, correctly assembled, aligned, secure, and not leaking excessively at seals.

(18) *Choke.* Before starting engines, see that choke operates freely (fig. 94). When starting engines in item (19), observe if action of automatic choke is satisfactory. Adjust choke setting, if necessary, according to instructions (par. 110).

(19) *Engine warm-up.* Start engines, noting if cranking motor action is satisfactory, and any tendency toward difficult starting, inadequate cranking speed, or unusual noise. Set hand throttle to idle engines at 625 revolutions per minute during warm-up.

(20) *Instruments.* (a) *Warning signals.* Do not drive vehicle while engine or transmission warning signals are lighted.

(b) *Ammeter.* Ammeter should show slight positive (+) charge at engine speeds above 1,400 revolutions per minute. High charge may be indicated until generator restores to battery current used in starting.

(c) *Engine temperature gages.* Engine temperature should rise gradually during warm-up to normal operating range, 160° to 180° F. Maximum safe operating temperature is 240° F.

(d) *Tachometers.* These instruments should register engine speed in revolutions per minute, and record accumulating engine revolutions.

(21) *Engine controls.* Observe if engine responds properly to controls and if controls operate without excessive looseness or binding.

(22) *Ignition timing.* Check ignition timing and reset if necessary as soon as engine is warm, and before driving vehicle (par. 73).

(23) *Siren.* See if siren is in good condition and secure. If tactical situation permits, test for proper operation and tone.

(24) *Lamps (lights) and reflectors.* Clean lenses and inspect all units for looseness and damage. If tactical situation permits, open and close all light switches to see if lamps respond properly.

(25) *Leaks—general.* Look under vehicle and within engine and fighting compartments for indications of fuel, oil, or coolant leaks. Trace any leaks found to their source, and correct or report them to higher authority.

(26) *Tools and equipment.* Check tools and vehicle stowage to be sure all items are present, and see that they are serviceable and properly mounted or stowed.

## 9. Run-In Test

a. **PROCEDURES.** Perform the following procedures (1) to (10) inclusive during the road test of the vehicle. If the vehicle has been driven 50 miles or more before delivery to the using organization, confine the road test to the least mileage necessary to make observations listed below.

**Caution:** Avoid continuous operation of the vehicle at speeds approaching maximums indicated on the caution plate during the road test.

(1) *Dash instruments and gages.* Do not move vehicle until engine temperature reaches 140° F. Maximum safe operating temperature is 240° F. Observe readings of ammeter, tachometers, temperature gages, and warning signal lights to be sure they are indicating the proper function of the units to which they apply. Warning signal lights go on when ignition is turned on, and go off as soon as oil pressure builds up. See that speedometer registers vehicle speed and that odometer records accumulating mileage.

(2) *Brakes: steering and parking.* Test steering brakes to see whether they will stop vehicle effectively with levers even, and that they start to meet resistance at approximately 6 to 8 notches from fully released position. See that parking lock mechanism holds levers in applied position. Test levers separately to be sure vehicle steers properly with normal pull.

(3) *Transmissions and transfer unit.* Vehicle should start satisfactorily in either "DRIVE" or "LOW" range. Be alert for abnormal conditions in transmissions, indicated by excessive slippage and engines racing when under load, severe shifting, or shifting in wrong speed range, also unusual conditions in transfer unit, indicated by hard shifting or severe gear clash. Gears should operate without unusual noise and not slip out of mesh during operation.

(4) *Engines.* Be on the alert for any unusual engine operating characteristics or unusual noise, such as a lack of pulling power or acceleration, backfiring, misfiring, stalling, overheating, or excessive exhaust smoke. Observe if engines respond properly to all controls and if control synchronization appears to be satisfactory.

(5) *Unusual noises.* Be alert throughout road test for noise from hull or attachments, suspensions, running gear, or tracks that might indicate looseness, damage, excessive wear, or inadequate lubrication.

(6) *Halt vehicle at 10-mile intervals or less for service.* Refer to (8) below.

## Section VI. OPERATION UNDER ORDINARY CONDITIONS

### 13. Use of Instruments and Controls in Vehicular Operation

*a. NEW VEHICLE RUN-IN TEST.* Before a new or reconditioned vehicle is placed in service, be sure that the new vehicle run-in test described in paragraph 9 has been performed.

*b. BEFORE-OPERATION SERVICE.* Perform the services in items (1) to (6) in paragraph 36 before attempting to start the engines. Start and warm up engines (par. 14) and complete the before-operation services.

**Caution:** Only gasoline with an octane rating of 80 or above can be used safely in this vehicle. Normally, the engines will not detonate (knock); if they do, it indicates either that the gasoline is of incorrect grade or that the ignition timing is incorrect. Check grade of fuel or readjust ignition timing (par. 73).

### 14. Starting Engines

*a. STARTING.* Under normal conditions, the engines should be started as follows: Set brakes. Place transmission selector lever in NEUTRAL, and place transfer unit shift lever in the range in which the vehicle is to be driven. Turn fuel pump on for right or left tank. Turn on ignition switches for both engines, which will cause engine and transmission oil pressure signals to go on. (If the signals do not light, make sure emergency ignition switch is turned on.) Press starter buttons for both engines until engines fire.

**Caution:** It is important to turn electric gasoline pumps on before attempting to start engines, and equally important to turn them off when the engines are stopped. Do not allow pumps to operate on a dry tank.

*b. WARM-UP.* After engines have started, pull hand throttle out to set idling speed at about 625 revolutions per minute, to prevent stalling during warm-up. Check to see that oil pressure warning signals go out. If these signals remain lighted, shut off engines and investigate cause. Check ammeter to see that generators are charging. Listen for unusual noises in power train or engines. The engines do not require any warm-up period in mild weather, except the time required to check the gages mentioned above. At temperatures below freezing, the warm-up periods given in paragraph 24 should be observed.

*c. FLOODING.* If engines do not start readily in mild or warm weather, check for flooded condition. This can usually be corrected by depressing accelerator fully and holding it down while cranking engines. As soon as the engines start, close throttle to prevent "racing." Flooding usually occurs more severely in one engine so that one engine starts and the other does not. In this case, shut off engine that is operating, press accelerator all the way down, and crank

flooded engine until it starts. The other engine can then be restarted with a minimum of "racing." Flooding may be caused by dirt on needle valve, or by stuck choke shaft. The stuck choke shaft can be freed as shown in figure 94.

*d. STARTING ONE ENGINE WITH THE OTHER.* If only one engine starts readily, it can be used to start the other engine by placing the transfer unit shift lever and the transmission selector in **NEUTRAL**, running the other engine at about 2,000 revolutions per minute, and then moving transmission selector lever to **DRIVE**.

**Caution:** Inspect "dead" engine to be sure it turns over freely before attempting to start it by use of the other engine.

*e. COLD WEATHER STARTING.* See paragraph 24 for detailed instruction on cold weather starting and warm-up.

## 15. Driving Vehicles

*a. DRIVING RANGES.* Normally, the vehicle is driven with the transmission selector lever in **DRIVE** and the transfer unit shift lever either in **HIGH** or in **LOW** range. Transfer unit **HIGH** range provides cruising gear ratios, and is to be used for traveling on roads or on relatively smooth, level terrain. Transfer unit **LOW** range provides power gear ratios, and is to be used for hill-climbing or for rough, sandy or muddy conditions.

*b. FORWARD DRIVING.*

**Caution:** Before driving vehicle make sure that gun is lowered and secure in travel lock, and that spade and gunner's platform are raised and locked in closed position (par. 19*b* and *c*). To start vehicle, shift transfer unit into **HIGH** or **LOW**, as conditions warrant, move transmission lever to **DRIVE**, release parking brake controls and depress accelerator. Vehicle will start moving forward at a speed in proportion to the amount the accelerator is depressed. The vehicle will start out in first gear and the transmission will automatically shift into second, third, and fourth gears as the vehicle speed increases and engine load decreases. As vehicle loses speed, either because accelerator pedal is released or due to upgrade, the transmission will shift down automatically to a lower gear.

*c. STEERING.* To steer vehicle, pull back on the right-hand steering lever to make right turn, or on the left-hand lever for a left turn. The lever that is being used should be applied firmly and then released fully, and this action repeated if necessary. The lever should not be held in a slightly applied position for long periods of time.

**Caution:** It is very important that the steering levers be held far enough forward to insure complete release of the bands at all times, except when steering or stopping; otherwise, brake lining wear will be excessive and oil will become overheated.

**d. REVERSE.** To operate vehicle in reverse, first bring it to a complete stop if in motion; then depress the neutral pedal to put the transmissions in **NEUTRAL**, and move the transfer unit shift lever up to **NEUTRAL**, over to the left and forward into **REVERSE**. Release the neutral pedal. Four speeds automatically selected in the hydramatic transmissions are available in reverse.

*Note.* Depressing the neutral pedal puts both transmissions in neutral by means of the same linkage as the selector lever, but leaves the driver's right hand free to shift the transfer unit. Releasing the pedal puts the transmission back in the range for which the selector lever is set. Neutral pedal should be used only when throttles are closed.

**e. ROUGH TERRAIN.** In negotiating rough or sandy terrain or heavy mud, not only should the transfer unit be shifted to **LOW** range, but the transmission selector lever should also be moved to **LOW** range to hold the transmission in second gear, and thus obtain the benefit of a steady pull. When the transmissions are in **LOW** range, they will up-shift only from first to second speeds, and will not go into third and fourth, thus permitting a steadier pull through very bad terrain, or providing more braking effect from engine compression when descending hills. Do not allow the engine speed to exceed 3,500 revolutions per minute for sustained periods.

*Note.* In negotiating long grades if transmission continually down-shifts and up-shifts back and forth, transfer unit must be shifted to high range to allow transmission to operate in its higher ranges.

**f. DESCENDING HILLS.** In descending moderately steep hills, the transfer unit should be shifted into **LOW** range before starting to descend. When descending long, very steep hills, the transmission selector lever should also be placed in **LOW** range before starting to descend, and brakes should be used to keep engine speeds below 3,500 revolutions per minute.

**Caution:** Transfer units shifts from **HIGH** to **LOW** must be made at speeds below 10 miles per hour. The **NEUTRAL** pedal must always be depressed when making the shifts.

## 16. Stopping Vehicle

To stop the vehicle, release the accelerator and pull back on both levers at the same time. There is no clutch to disengage. Both levers should be pulled back and engaged with heavy pressure, and then released fully. If the stop is to be made from relatively high speed, it is advisable to use heavy pressure intermittently rather than a continuous but lighter pressure.

**Caution:** Do not press down on neutral pedal when stopping, unless the transfer unit is to be shifted. Do not use neutral pedal as a clutch when starting.

## 17. Stopping Engines

To stop the engines, close the throttle until engines are idling at approximately 450 revolutions per minute. Run at this speed for 3 or 4 minutes and then turn off both ignition switches and shut off the fuel pump switch. If engines are extremely hot, run at 2,000 revolutions per minute for a few minutes to cool down before reducing speed to normal idle. Finally, open master battery switch.

**Caution:** Always turn off ignition switches before opening master battery switches. Never operate engines with master switch off.

## 18. Towing Vehicle

a. **TOWING TO START VEHICLE.** The engines can be started in an emergency by towing the vehicle, provided the following procedure is observed after checking to make sure the engines turn freely:

- (1) Release brakes.
- (2) Place transmission selector lever in **NEUTRAL** and transfer unit shift lever in **LOW**.
- (3) When speed reaches approximately 4 miles per hour, turn on both ignition switches and one fuel pump switch, and move transmission selector lever to **DRIVE**.

- (4) Continue towing until engines fire.

b. **TOWING A DISABLED VEHICLE.** When towing a vehicle, several precautions must be taken:

- (1) Tow the vehicle with the transfer unit in **NEUTRAL**, if possible. If transfer unit is damaged or disabled, disconnect the propeller shaft at the controlled differential pinion shaft yoke.

- (2) If controlled differential is disabled, disconnect the two short propeller shafts at the final drive yokes.

- (3) If final drive units are disabled, break tracks and two vehicle on track suspension wheels.

**Caution:** Tow bar must be used under these circumstances.

c. **TOWING PROCEDURES.** In towing a vehicle, changes in direction must be made by a series of slight turns so that the vehicle being towed is, as nearly as possible, directly behind the one doing the towing. This prevents the cable from contacting the track which might damage both the cable and track blocks. If no operator is available to steer the disabled vehicle, or if it is being towed with the tracks removed, the cable should be attached by the "short hitch" in which it is threaded through both eyes on the vehicle to be towed, and then crossed and passed through both shackles of the towed vehicle.

**Caution:** Tow bar must be used when towing vehicle with tracks removed.

## Section VII. HOWITZER MOUNT CONTROLS AND OPERATION

### 19. Controls

a. **GENERAL.** The howitzer mount is located at rear of vehicle and is assembled on a continuous bearing. The mount may be traversed  $17^{\circ}$  to left or  $21^{\circ}$  to the right by means of a hand crank. The mount has two travel locks consisting of a traverse and a howitzer lock. Both travel locks (fig. 16) should be used when the vehicle is being driven over the terrain. The howitzer can be elevated  $45^{\circ}$  or depressed  $5^{\circ}$  from the horizontal position by means of a hand crank or an electrical mechanism. The rear of the vehicle is fitted with a spade and gunner's platform which serves as a tailgate when in the **RAISED** position and as an anchor and platform when in the **LOWERED** position (figs. 14 and 15).

b. **WINCH CRANK** (fig. 14). The winch is operated from either end of the crankshaft by one or both of the cranks provided. When operat-

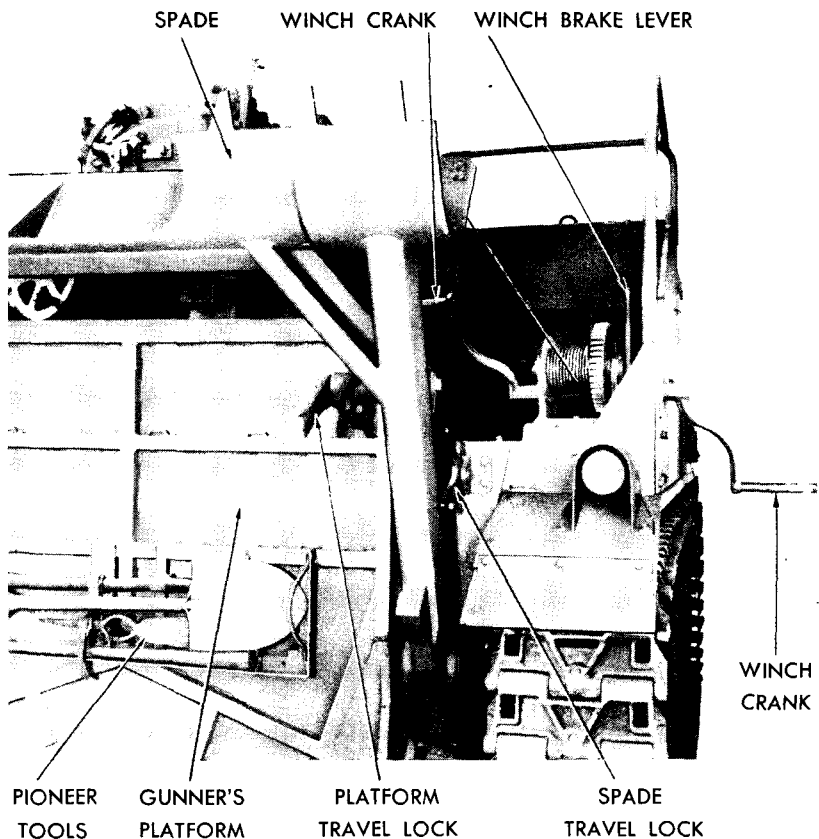


Figure 14. Spade and gunner's platform.



ing the winch from the gunner's compartment, the crank is turned counterclockwise to raise the platform and spade assembly, and clockwise to lower the assembly. When operating the winch from the side of the vehicle the crank is turned clockwise to raise the spade and platform assembly, and counterclockwise to lower the assembly.

c. **WINCH BRAKE LEVER** (fig. 14). The winch brake lever is located on the right side of the winch frame. The lever is moved toward the rear of the vehicle to apply the brake.

d. **WINCH LOCKING PAWL**. The locking pawl is located on the front right side of the winch frame. The pawl is hand-released when tension is on the cable, by turning the crank in the gunner's compartment counterclockwise. The locking pawl when engaged with the drum gear provides a safety lock while raising the platform and spade assembly.

e. **SPADE TRAVEL LOCK** (fig. 14). The two spade travel locks are toggle latches, bracket-mounted on the rear of the vehicle. The latches engage studs on the spade when the spade assembly is in the raised position. The travel locks are swung upward to release and downward to lock the spade assembly.

f. **PLATFORM LOCK** (fig. 14). The two platform locks are pivot-mounted on the arms of the spade. The locks are used to hold the platform in the closed position when the spade is raised.

g. **HOWITZER TRAVEL LOCK** (fig. 16). The gun travel lock is mounted on the hull roof above the driver's compartment. The lock is used to hold the weapon tube in traveling position. The lock is secured by swinging up to a vertical position, clamping upper half of lock around tube and tightening clamp nut. The lock is released by loosening clamp nut at top of clamp, tilting nut away from gun tube, and lifting upper half of lock away from weapon tube.

h. **TRAVERSE LOCK** (fig. 16). Two traverse locks consisting of lock clamps and lock nuts and are mounted on the rear of the weapon base. The locks are used to secure the howitzer and take the play out of the traversing mechanism. The locks are released by inserting end of utility bar in hole in clamp nut, loosening nut until lock clamp can be freed from weapon mount base. The locks are secured by placing the lock clamps in position at rear of weapon base and tightening clamp nuts.

i. **TRAVERSING HANDWHEEL** (fig. 17). The traversing handwheel is located at the rear left side of the howitzer. It is used to traverse the howitzer after disengaging travel lock, traversing locks, and elevating howitzer slightly to clear travel lock.

j. **HAND-OPERATING ELEVATION WHEEL** (fig. 17). The hand-operating elevation wheel is located at the rear left of the howitzer. It is used to raise or lower the howitzer manually. Before using the hand-operating elevation wheel, the control lever in the elevation mechanism

(3) To remove the head from the periscope body, turn the two eccentric assemblies located on the sides and upper part of the periscope body until the head clamp is completely disengaged from the latches of the eccentric mechanism and lift the head from the periscope body. When installing the head, position it on the top of the periscope body with the window facing the front side of the periscope. Turn the eccentric assemblies until the reference arrow on each eccentric matches the corresponding arrow on the periscope body. See that the handles of the eccentric mechanism lay flat on the sides of the periscope body.

## Section IX. OPERATION UNDER UNUSUAL CONDITIONS

### 23. Cold Weather Preparation

*a. GENERAL.* The operation and maintenance of this vehicle at low temperatures involves factors which do not exist at normal temperatures. Since subzero temperatures affect both metals and lubricants, problems are presented that demand special precautions. Operators and maintenance personnel must spend more time in protective maintenance. Failure to give this extra service will result in actual damage, unnecessary and unwarranted expense, and failure to start.

*b. FUELS.* (1) *Prescribed fuel.* Winter grades of gasoline are designed to reduce cold weather starting difficulties; therefore, use the winter grade fuel during cold weather operation. Use winter grade gasoline procured under United States Army Specification 2-103, grade C, latest revision.

(2) *Special precautions.* The formation of ice crystals from small quantities of water in the fuel sometimes causes considerable trouble. The following precautions should be followed to keep water out of the fuel tanks:

(a) Strain fuel through suitable strainer. **Caution:** A positive metallic contact must be provided between fuel container and fuel tank unless both fuel tank and container are independently grounded.

(b) Always keep the fuel tank as full as possible. This will reduce condensation of water from the free air space above the fuel.

(c) Add 1 quart of denatured alcohol (grade 2) to each tank of fuel at start of winter season and 1 pint to each 10 gallons of fuel at each refueling. The alcohol will absorb the water and prevent it from freezing.

(d) Do not store fuel in old oil or gasoline drums unless they have been thoroughly cleaned.

(e) Never pump fuel drums dry when filling the vehicle fuel tanks; allow about 4 inches of fuel to remain. This residue can later be transferred to a settling tank. If time is not an urgent consideration, do not pump fuel from drum to vehicle until it has settled for 24 hours

after filling or moving. Keep portable fuel pumps clean and protected from snow and frost.

(f) When a drum has been opened, be sure that the opening is covered or the bung replaced to prevent snow, frost, or other foreign matter from entering. Store drums in a covered building or cover them with tarpaulin.

c. LUBRICATION. (1) *General*. Lubrication above 0° F. is covered in the lubrication order. The following instructions are intended to supplement this information and apply only in instances where the temperature falls below 0° F. for long periods.

(2) *Wheel and track roller bearings*. If vehicle has been driven 1,000 miles using general purpose grease (No. 0) for lubrication, no special precautions are necessary for the wheels and track roller bearings. If quantities of general purpose grease (No. 1) are in these bearings, it will be necessary to disassemble and wash in dry cleaning solvent, dry and then relubricate with general purpose grease (No. 0) for satisfactory operation.

d. COOLING SYSTEM. (1) *Antifreeze*. Cooling systems will be protected with antifreeze compound for operation below +32° F. The following instructions apply to use of new antifreeze compound. For use of reclaimed antifreeze solutions, refer to TM 9-850.

(2) *Cleaning cooling system*. If the cooling system has been cleaned recently, it may be necessary only to drain, refill with clean water, and again drain. Otherwise, the system can be cleaned with cleaning compound (par. 115).

(3) *Draining cooling system*. Each cooling system (40-quart capacity) is drained at one point; that is, a plug marked "WATER" in the bottom of each transmission oil pan (fig. 27). Remove the radiator cap for rapid and complete draining of the system.

(4) *Leakage inspection*. Inspect all hoses and replace if deteriorated. Inspect hose clamps and plugs and tighten if necessary. Radiator leaks will be repaired before adding antifreeze compound. Correct exhaust gas or air leakage into the cooling system. Tighten the cylinder head screws if there is any indication of a coolant leakage. Replace the cylinder head gasket if necessary.

(5) *Thermostats*. Inspect thermostats to see that they close completely. Look for evidence of sticking in open or closed position. Operation of thermostats can be checked by heating in a pail of water to make certain that they will open in hot water. If a thermostat does not open or close completely, does not function freely, or is badly rusted, it should be replaced.

(6) *Adding antifreeze*. When the cooling system is clean and tight, fill the system with water to about one-third capacity. Then add antifreeze compound to the cooling system as indicated below. The system

should be protected to at least 10° F. below the lowest expected temperature to be experienced during the winter season.

<i>Pints, antifreeze compound (ethylene glycol type)</i>	
<i>Freezing points</i>	<i>per system</i>
10° F.	20
0° F.	25
−10° F.	30
−20° F.	35
−30° F.	40
−40° F.	45
−50° F.	50

After adding antifreeze compound, fill with water to the prescribed level; then start and warm the engine to normal operating temperature. Stop the engine and check solution with a hydrometer, adding antifreeze compound if required. In service, inspect the coolant weekly for strength and color. Rusty solution should be drained, the cooling system thoroughly cleaned, and new solution of the required strength added.

*e. ELECTRICAL SYSTEMS.* (1) *Generator and cranking motor.* Check the brushes, armature commutators, and bearings. Be sure that the armature commutators are clean. The large surges of current which occur in starting the cold engines require good contact between brushes and armature commutators.

(2) *Wiring.* Check, clean, and tighten all connections, especially battery terminals. Care must be taken that no short circuits are present.

(3) *Coils and condensers.* Check coils and condensers for proper functioning.

(4) *Distributors.* Clean distributors thoroughly. Check the points frequently and replace as necessary. Pitted points may keep the engines from starting.

(5) *Spark plugs.* Test and replace spark plugs if necessary. If it is difficult to make the engines fire, reduce the gap from 0.030 to 0.025 inch. This will make sparking easier at the reduced voltages likely to prevail.

(6) *Ignition timing.* See paragraph 73 for detailed procedure.

(7) *Batteries.* The efficiency of a battery drops sharply with decreasing temperatures and becomes practically nil at −40° F. Do not try to start the engines with the battery when it has been exposed to temperatures below −30° F. without first warming up battery. Be sure that the battery is always fully charged with the hydrometer reading between 1275 to 1300. A fully charged battery will not freeze at temperatures usually encountered even in arctic climates, but a dis-

charged battery will freeze at 5° F. Do not add water to a battery when it has been exposed to subzero temperatures unless the battery is to be charged immediately. If water is added and the battery is not put on charge, the layer of water will stay at the top and freeze before it has a chance to mix with the acid.

(8) *Starting.* Before every start, be sure there is no ice or moisture on the wiring or other electrical equipment.

(9) *Battery outlet.* An outlet is provided for ready connection of a battery for charging the vehicle batteries or supplying additional current for cranking (par. 83).

## 24. Cold Weather Operation

a. **STARTING AND OPERATION.** (1) *Temperatures from -10° to -30° F.* (a) It is possible to start gasoline engines with batteries at temperatures as low as -30° F. if the engines are properly lubricated, in good mechanical condition, and the battery is fully charged. If the vehicle is equipped with a winterization kit, always use the heater to warm up the engines.

(b) Prior to attempting a start, see that everything is in readiness so that the engine will start on the first trial. Try to avoid having the engines fire a few times and then stop. Water is one of the products of gasoline combustion, and in a cold engine this water may form a frost and make it impossible to start without heating the engine to above 32° F.

(c) Start one engine at a time, with the accelerator and hand throttle fully closed. This will set the automatic choke correctly. No further choking is possible or necessary. Start one engine with another (par. 14) if battery capacity is low.

**Caution:** Do not pump or depress the throttle pedal swiftly to the floor before starting the engine. This will force raw gasoline into the cylinders, causing flooding, decrease oil film in the cylinders and hinder starting.

(d) After the engines have started, set the hand throttle to allow them to run at 800 to 900 revolutions per minute for 4 to 5 minutes, to allow the oil to warm up before opening the throttle further. This should be done with the transmission selector lever in neutral. Then shift the selector lever to DRIVE and allow the engine to idle for several minutes more to warm up the oil in the transmission. Do not drive the vehicle over 5 miles per hour for at least 10 minutes after starting, to permit the oil in the transfer unit and controlled differential to warm up.

(2) *Temperature below 30° F.* (a) Cover engines with tarpaulin, tent, or portable shed. Place oil stoves, firepots, or four to five ordinary kerosene lanterns under the covering about 3 hours prior to the time the start is to be made.

(b) Keep the vehicle in sheltered areas, especially areas sheltered from wind. Cold winds increase starting difficulties.

(c) If the vehicle is equipped with a winterization kit, keep the heater operating and the covers closed whenever the engines are not operating.

**b. STOPPING ENGINES.** Increase engine speed just before turning off ignition; then turn off ignition switches, releasing accelerator at the same time. As the engine coasts to a stop, it will blow out all the residual products of combustion and leave only air and gasoline vapors in the engine.

**c. INSPECTION.** Inspect the vehicle frequently. Shock resistance of metals, or resistance against breaking, is greatly reduced at extremely low temperatures. Operation of vehicles on hard, frozen ground causes strain and jolting which will result in screws breaking or nuts jarring loose.

## **25. Operation Under Dusty Conditions**

**a. GENERAL.** When operating under dusty or sandy conditions, special precautions must be taken to prevent excessive wear and damage to the moving parts of the power unit and suspension system.

**b. AIR CLEANERS AND BREATHERS.** Under extremely dusty conditions, the air-cleaner oil reservoirs must be cleaned every 2 to 4 hours, or more frequently as required. Air-cleaner elements must be cleaned when inspection reveals that any appreciable quantity of dirt has accumulated to restrict the free flow of air or their capacity to trap the dust has been reached. Continued operation of the engine with dirty or saturated air cleaners will cause damage to the engine which will continue and increase long after the air cleaners have been cleaned. The final drive breathers must be cleaned more frequently as required when operating under dusty conditions to prevent premature wear and damage to these units. The engine oil filter will be cleaned more frequently as required to maintain its efficiency. Carefully examine all lubricating oil bayonet gages for evidence of gritty substance that would indicate the oil has become contaminated and must be changed.

**c. COOLING SYSTEM.** Inspect radiators and oil coolers frequently to make sure air passages are not restricted by accumulation of dirt. Clean the radiator cores by flushing with water under pressure or blow out with compressed air.

**d. CARE OF TRACK SUSPENSION SYSTEM UNDER DUSTY CONDITIONS.** Lubricate track-suspension system more frequently to cleanse the bearings of any sand or dirt that may have worked into the hubs or housings. Inspect track-suspension system units including track links for evidence of premature wear. Remove worn units promptly and install new ones to prevent ultimate failure.

## **26. Submersion**

*a. GENERAL.* If a vehicle has been submerged in water, particularly salt water, the problem of arresting rust and corrosion calls for immediate action, if the tactical situation permits.

*b. STOPPING RUST AND CORROSION AFTER SUBMERSION.* Remove water from every part of the vehicle and dry all exposed parts with cloths and compressed air. If the suspension system has been submerged for even a few minutes, lubricate all suspension points to cleanse the bearings of water and grit. Coat all parts accessible, inside and out, with preservative lubricating oil. If preservative compounds are not available immediately, use ordinary engine oil temporarily until preservative compounds can be obtained. In an emergency, leave vehicle submerged to keep air from wet metal parts until preservative compounds can be secured. In the case of assemblies which have to be disassembled and dried, perform these operations as soon as the tactical situation permits.

*c. PERMANENT PROTECTION.* Regardless of the temporary steps taken as outlined in subparagraph *b* above, the vehicle must be delivered at the earliest possible moment to higher echelons for disassembly, cleaning, repair, and permanent protection. The higher echelons must pay particular attention to possible damage caused by the sudden cooling of parts of the engine or transmission which were at operating temperatures at the time of submersion. If submerged in salt water for any length of time, aluminum or magnesium parts will probably be unfit for further use and must be replaced.

## **Section X. DEMOLITION TO PREVENT ENEMY USE**

### **27. General**

*a.* Destruction of the vehicle, when subject to capture or abandonment in the combat zone, will be undertaken by the using arm only when, in the judgment of the military commander concerned, such action is necessary.

*b.* The instructions which follow are for information only. Certain of the methods of destruction outlined require TNT and incendiary grenades which may not be normal items of issue. The issue of these materials, and the conditions under which destruction will be effected, are command decisions in each case, according to the tactical situation.

*c.* If destruction is resorted to, the vehicle must be so badly damaged that it cannot be restored to a usable condition in the combat zone either by repair or cannibalization. Adequate destruction requires that all parts essential to the operation of the vehicle be destroyed or damaged beyond repair. Equally important, the same essential parts must be destroyed on all like vehicles so that the enemy cannot construct one complete operating unit from several partially damaged ones.

## 28. Detailed Instructions

*a.* DESTRUCTION OF SIGHTING AND FIRE-CONTROL EQUIPMENT. All fire-control equipment, including optical sights and binoculars, is difficult to replace. It should be the last equipment to be destroyed, if there is any chance of personnel being able to evacuate. If evacuation of personnel is made, all possible items of fire-control equipment must be destroyed. Thoroughly burn firing tables, trajectory charts, slide rules, and similar items. Thoroughly smash all optical equipment.

*b.* DESTRUCTION OF 155-MM HOWITZER. (1) *Methods.* Four methods of destroying the howitzer are outlined below in their order of effectiveness. These instructions apply to the howitzer only. To effect demolition of the entire howitzer motor carriage, destruction as outlined in this subparagraph must be accomplished in conjunction with destruction of the vehicle itself (subpar. *c* below) and the sighting and fire-control equipment (subpar. *a.* above).

(2) *Method No. 1.* (*a*) Open drain plug on recoil mechanism, allowing recoil fluid to drain. It is not necessary to wait for the recoil fluid to drain completely before firing the cannon in step (*d*) below.

**Caution:** Firing the cannon with drained recoil mechanism without proceeding with steps (*b*) and (*e*) below is not a satisfactory method of destruction.

(*b*) Place an armed (safety pin removed) antitank grenade M9A1, HE, or armed (safety pin removed) antitank rocket M6 in the tube with the nose end toward the rear. The grenade or rocket must be centered in the tube, using a wooden adapter. An alternate for the wooden adapter is the use of waste.

(*c*) Insert an unfuzed HE complete round or HE shell with propelling charge into the cannon and close the breech. Base-detonating HE shell cannot be used in this method.

(*d*) Fire the cannon, using a lanyard at least 100 feet long. The person firing should be under cover to the rear of the piece and approximately 20° off the line of fire. Elapsed time: Approximately 2 to 3 minutes.

(*e*) The danger zone is approximately 500 yards.

(3) *Method No. 2.* (*a*) Insert TNT blocks in the bore, near the muzzle, and in the chamber of the cannon. Close the breechblock as far as possible without damaging the safety fuse. Plug the muzzle tightly with earth to a distance of approximately 3 calibers from muzzle. Detonate the TNT charges simultaneously. Thirty to fifty half-pound blocks will be needed for effective demolition. If it is not possible to plug the bore, a larger number of TNT blocks will be needed or effective demolition.

(*b*) Ram an HE shell (without base fuze) into the forcing cone and place TNT blocks behind it, as specified above. Close the breechblock and detonate the TNT charge. A sufficient length of safety fuse



should be used to permit personnel to reach safety zone or cover. The fuse may be routed through the primer hole in the spindle.

(c) Attention is invited to the fact that, for the larger calibers, the number of blocks to be used is an estimate not proved by tests.

(4) *Method No. 3.* (a) Place unfuzed incendiary grenades M14 on their sides, one on top of another, in the chamber. Close the breech. Equip another incendiary grenade with a 15-second safety fuse, ignite, and toss it in the muzzle. Quickly elevate the cannon to its maximum elevation. Elapsed time: 3 to 5 minutes. Six to eight grenades per cannon are required.

(b) The metal from the grenades will fuse with the interior of the breechblock, making it impossible to open the breech.

(5) *Method No. 4.* (a) Fire adjacent cannons at each other at point-blank range, using HE or AP shells. Two or more direct hits from a weapon of the same caliber, on a vital spot such as the breech mechanism, recoil mechanism, or tube, should adequately destroy the artillery piece. Fire from cover. Danger space is from 200 to 250 yards.

(b) Destroy the last weapon and carriage by the best means available.

(c) Danger from cannibalization is inherent in this method.

(6) *Ammunition.* Instructions for demolition of ammunition are contained in TM 9-1901.

c. **DESTRUCTION OF VEHICLE.** Three methods of destroying the vehicle are outlined below in their order of effectiveness. These instructions apply to the vehicle only. To effect demolition of the entire howitzer motor carriage, destruction as outlined in this subparagraph must be accomplished in conjunction with destruction of the cannons, and sighting and fire-control equipment (a and b above).

(1) *Method No. 1—by explosives.* (a) Remove and empty portable fire extinguishers. Puncture the fuel tanks.

(b) Prepare a 3-pound and a 2-pound TNT charge, with tetryl non-electric caps and about 6 feet of safety fuse in each charge. Open the engine compartment and place the 3-pound charge between the engines. Place the 2-pound charge against left side of the transfer unit, as near differential as possible. Place a ½-pound charge of TNT against left fuel tank. Use only a cap (no fuse) in this charge. Point the cap end toward the 3-pound charge.

**Caution:** If charges are prepared beforehand and carried in the vehicle, keep the caps and fuses separated from the TNT charges until they are to be used.

(c) If sufficient time and materials are available, prepare and place a 2-pound TNT charge at the center of each track assembly.

(d) Ignite the TNT charges and take cover.

(2) *Method No. 2—by gun fire.* (a) Remove and empty portable

fire extinguishers. Puncture the fuel tanks. Open all doors and hatches.

(b) Fire on the vehicle, using adjacent howitzer motor carriages, tanks, antitank or other artillery, or antitank rockets or grenades. Aim at the engine compartment, suspension, and armament in the order named. If a good fire is started, the vehicle may be considered destroyed.

(c) Destroy the last remaining vehicle by the best means available.

(3) *Method No. 3—by fire.* (a) Remove and empty portable fire extinguishers. Puncture the fuel tanks.

(b) Using an ax, pick, sledge, or any other heavy object, smash all vital elements, such as distributors, carburetors, air cleaners, generators, spark plugs, lights, instruments, and control levels. Destroy the radio sets by shearing off all panel knobs, dials, and switches. Break sockets, smash tubes, coils, microphones, earphones, and batteries. If time permits and a sufficiently heavy object is available, smash the engine blocks, crankcases, and transmissions.

(c) Pour spare gasoline or oil over the entire vehicle and ignite.

## **PART THREE**

### **MAINTENANCE INSTRUCTIONS**

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#### **Section XI. GENERAL**

##### **29. Scope**

Part Three contains information for the guidance of the personnel of the using organizations responsible for the maintenance (crew and battery) of this equipment. It contains information for the performance of the scheduled lubrication and preventive maintenance services, as well as description and maintenance of the major systems and units and their functions in relation to other components of the equipment.

#### **Section XII. ORGANIZATIONAL SPARE PARTS, TOOLS AND EQUIPMENT**

##### **30. Organizational Spare Parts, Tools and Equipment**

*a. SPARE PARTS.* A set of organizational spare parts is supplied to the using arm for field replacement of these parts most likely to become worn, broken or otherwise unserviceable.

*b. TOOLS AND EQUIPMENT.* A set of organizational tools and equipment is supplied to the using arm for maintaining and using the matériel. This set contains items required for disassembly, assembly, cleaning and preserving the 155-mm. Howitzer Motor Carriage M41. Tools and Equipment should not be used for purposes other than prescribed and, when not in use, should be properly stored in the chest and/or provided for them.

*c. LIST OF SPARE PARTS, TOOLS AND EQUIPMENT.* Spare parts, tools and equipment supplied for the 155-mm. Howitzer Motor Carriage M41 are listed in WD Catalog ORD 7 SNL G-236 which is the authority for requisitioning replacements.

##### **31. Specially Designed Tools and Equipment**

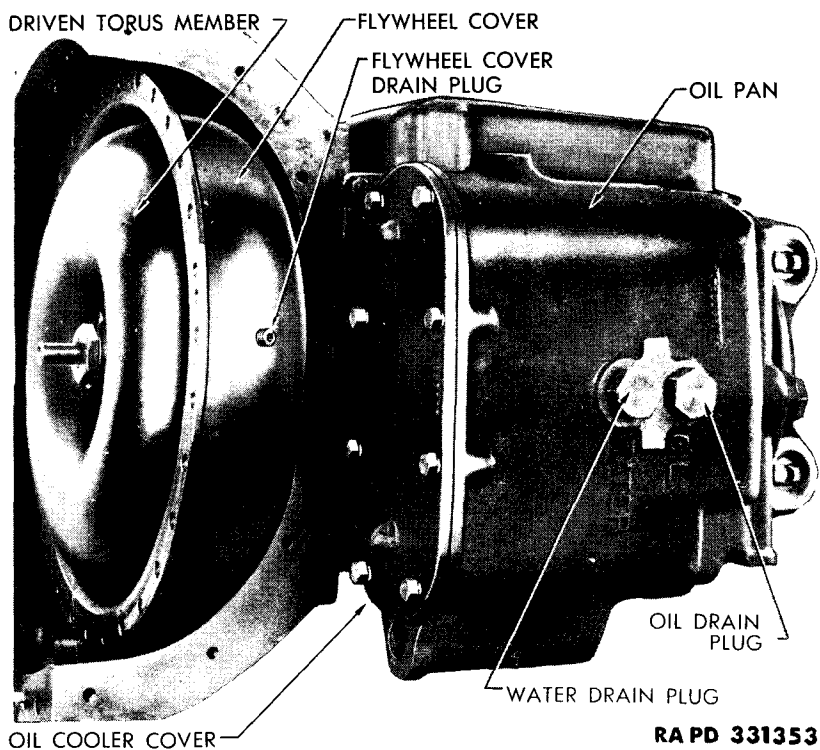
Certain tools and equipment listed in WD Catalog ORD 7 SNL G-236 are specially designed for maintenance, repair and general use with the 155-mm. Howitzer Motor Carriage M41. These tools and equipment are listed below for information only. This list is not to be used for requisitioning replacements.

Item	Identifying No.	References		Use
		Fig.	Par.	
ADAPTER, bearing race remover.	41-A-12-550, A7079201			
ADAPTER, puller, slide hammer, torsion bar and compensating link pin replacer.	41-A-18-245, B7079311	137, 141	146, 147, 149	Suspension component replacement.
BOLT, eye, transmission lifting.	41-B-1586-300, A266327, KM-J-1636-SA-5.		123	Transmission replacement.
CABLE, extension rubber covered with female plugs at both ends, double conductor, stranded No. 1 AWG 20 feet long.	17-C-568, B257839			
FIXTURE, track connecting and connector pulling.	41-F-2997-86, D78191	131	144	Track replacement.
GAGE, adjusting, rear, servo (used in transmissions 1-M-H-19875 and up).	41-G-12, A344920, KM-S-1460-A.			
GAGE, transmission, oil pressure.	41-G-446, B298875, KM-S-1467-M6.			
HANDLE, for removers and replacers (length over-all 8 1/2 inches).	41-H-1397, A380406, TEC-4-223			Used with removers and replacers.
LIFTER, track wheel, right and left, in set.	41-L-1400, A7079701	138	148	Suspension component replacement.
LIFTER, valve, remover and replacer.	41-L-1425, B226787			
PIN, drift, black pin.	41-P-596-300, B7080501	131	144	Track replacement.
PULLER, end, shock absorber.	41-P-2907-196, A7079316	145	151	Shock absorber replacement.
PULLER, slide hammer type, bogie guide.	41-P-2957-33, C73615	137, 141	146, 147, 149	Suspension component replacement.
REMOVER, roller, outer bearing race track support.	41-R-2373-120, B7080557			
REPLACER, bearing and seal, track and compensating wheel.	41-R-2383-950, B296108, BMD-T-70-103.	140	145, 148	Do.
REPLACER, grease retainer.	41-R-2390-450, B296095, BMD-T-70-121.	134, 135	145, 148	Do.
REPLACER, retainer, grease (track support roller).	41-R-2396-375, B7080461	143	151	Do.

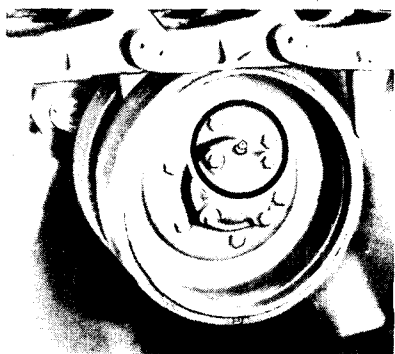
Item	Identifying No.	References		Use
		Fig.	Par.	
REPLACER, seal, track support roller-----	41-R-2397-875, A380369, BMD-T-70-102.	144	151	Suspension component replacement. Use with 41-R-2373-120.
SCREW, remover, bearing, threaded, 1¼ inch 12NF-2, length overall 8¾ inches.	41-S-1047-200, A7079203.	-----	-----	
SLING, engine, lifting.	41-S-3831-300, C7079282.	67	67, 68	Engine replacement. Final drive replacement.
SLING, final drive, lifting-----	41-S-3832-35, C7079301.	126	141, 142	

### 33. Detailed Lubrication Instructions

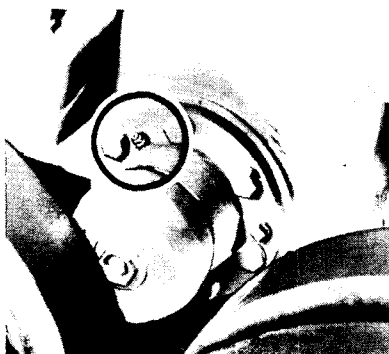
a. LUBRICATION EQUIPMENT. Each piece of matériel is supplied with lubrication equipment adequate to maintain the matériel. This equipment will be cleaned both before and after use. Lubrication guns will be operated carefully, and in such a manner as to insure a proper distribution of the lubricant.



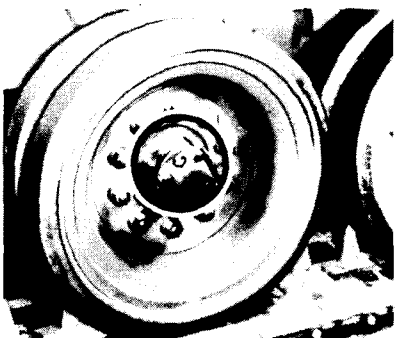
*Figure 25. Transmission drains.*



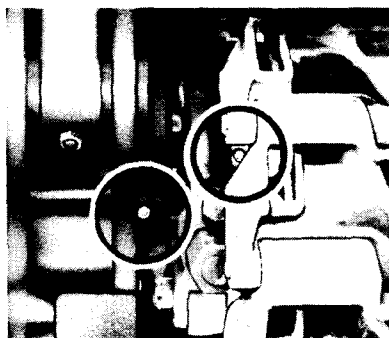
**A. TRACK SUPPORT ROLLER**



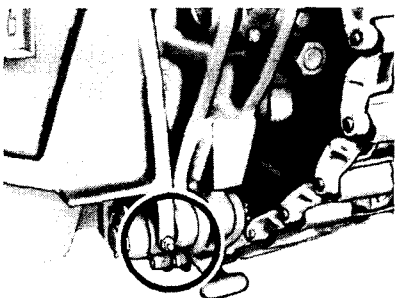
**B. TORSION ARM BEARING**



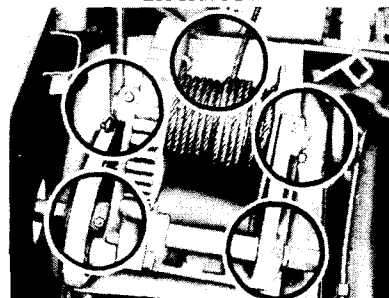
**C. TRACK WHEEL**



**D. COMPENSATING WHEEL  
LINKAGE**



**E. GUNNER'S PLATFORM  
HINGE PIN**



**F. PLATFORM AND SPADE  
WINCH**

*Figure 26. Lubrication points on track suspension and gunner's platform.*

## **Section XIV. PREVENTIVE MAINTENANCE SERVICES**

### **34. General Information**

*a. RESPONSIBILITY AND INTERVAL.* Preventive maintenance services as prescribed by AR 850-15 are a function of using organization maintenance personnel, and their performance is the responsibility of the commanders of such organizations. These services consist generally of Before-operation, During-operation, At-halt, After-operation, and Weekly Services performed by the crew, and the scheduled services to be performed at designated intervals by battery maintenance personnel.

*b. DEFINITION OF TERMS.* The general inspection of each item applies also to any supporting member or connection, and is generally a check to see whether or not the item is in good condition, correctly assembled, secure, or excessively worn.

(1) The inspection for "good condition" is usually an external visual inspection to determine whether the unit is damaged beyond safe or serviceable limits. The term "good condition" is explained further by the following: not bent or twisted, not chafed or burned, not broken or cracked, not bare or frayed, not dented or collapsed, not torn or cut, not deteriorated.

(2) The inspection of a unit to see that it is "correctly assembled" is usually an external visual inspection to see whether it is in its normal assembled position in the vehicle.

(3) The inspection of a unit to determine if it is "secure" is usually an external visual examination; a wrench, hand-feel, or a pry-bar check for looseness. Such an inspection must include any brackets, lock washers, lock nuts, locking wires, or cotter pins used in assembly.

(4) "Excessively worn" will be understood to mean worn beyond serviceable limits, or to a point likely to result in failure if the unit is not replaced before the next scheduled inspection.

### **35. Crew Maintenance**

*a. PURPOSE.* To insure mechanical efficiency, it is necessary that the vehicle be systematically inspected at intervals each day it is operated and weekly so defects may be discovered and corrected before they result in serious damage or failure. Certain scheduled maintenance services will be performed at these designated intervals. Any defects or unsatisfactory operating characteristics beyond the scope of first echelon to correct must be reported at the earliest opportunity to the designated individual in authority. The services set forth in paragraphs 36, 37, 38, and 39, are those performed by the crew Before-operation, During-operation, At-halt, and After-operation and Weekly.

*b. USE OF WAR DEPARTMENT FORM 48.* Driver preventive maintenance services are listed on the back of War Department Form 48



(Driver's Trip Ticket and Preventive Maintenance Service Record) to cover vehicles of all types and models. Items peculiar to this vehicle but not listed on Form 48, are covered in manual procedures under the items with which they are related. Certain items listed on the form that do not pertain to this vehicle are eliminated from the procedures as written into the manual. Every organization must thoroughly train each driver in performing the maintenance procedures set forth in this manual, whether, or not they are listed specifically on Form 48. The items listed on Form 48 that apply to this vehicle are expanded in this manual to provide specific procedures for accomplishment of the inspections and services. The services are arranged to facilitate inspection and conserve the time of the driver, and are not necessarily in the same numerical order as shown on Form 48. The item numbers, however, are identical with those shown on that form.

### **36. Before-Operation Service**

*a. PURPOSE.* This inspection schedule is designed primarily as a check to see that the vehicle has not been damaged, tampered with, or sabotaged since the After-operation Service was performed. Various combat conditions may have rendered the vehicle unsafe for operation and it is the duty of the driver to determine whether or not the vehicle is in condition to carry out any mission to which it may be assigned. This operation will not be entirely omitted, even in extreme tactical situations.

*b. PROCEDURES.* Before-operation Service consists of inspecting items listed below according to the procedure described, and correcting or reporting any deficiencies. Upon completion of the service, results should be reported promptly to the designated individual in authority.

(1) *Item 1, Tampering and damage.* Look over vehicle, equipment, and armament for damage which may have occurred from falling debris, shellfire, sabotage, or collision since parking vehicle. Open engine compartment and look for signs of tampering or sabotage, such as loosened or damaged accessories, loose fuel or oil lines, or disconnected throttle linkage.

(2) *Item 2, Fire extinguishers.* Examine cylinder of fixed system for tight mountings and closed valves. See that wire seal is intact. Look into engine compartment to examine extinguisher lines and nozzles for good condition and correct aiming. Be sure nozzles are not clogged. Inspect portable extinguishers for good condition and security. Make sure that wire seals are intact.

(3) *Item 3, Fuel, oil, and water.* Check amount of fuel in each fuel tank and add where required. Check oil level in each engine. Add as much oil as necessary bring level to FULL mark. Check level of

coolant in each radiator and add water if necessary. In freezing weather, be sure to add antifreeze compound of proper strength when considerable water must be added.

**Caution:** Do not fill fuel tanks or radiators to overflowing. Leave room for expansion.

(4) *Item 4, Accessories and drives.* Examine security of mountings of all accessible accessories and of generator and fan drive belts on each engine. See that fan and generator belts have  $\frac{5}{8}$ - to  $\frac{3}{4}$ -inch, finger-pressure deflection.

(5) *Item 6, Leaks, general.* Look under vehicle for any indications of fuel, oil, or water leaks. Inspect engine compartment for evidence of leaks, particularly at engine oil pan, and at fuel and oil lines. Trace all leaks to their sources and correct or report them to proper authority. Close engine compartment.

(6) *Item 7, Engine warm-up.* Start engines (par. 14). Observe if choke action is satisfactory. Note action of starter mechanism, particularly whether starter has adequate cranking speed. If low-oil-pressure warning light does not go out, engine should be stopped and trouble corrected or reported to designated authority. Inspect hand throttle for free operation; return it to idling position and let engine idle while proceeding with the following Before-operation Service.

(7) *Item 9, Instruments.* (a) *Warning signals.* The warning signals for engines and transmissions should go on when ignition switches are turned on, and should go out as soon as engines are started.

(b) *Tachometers.* Observe both tachometers to see that they indicate approximate engine revolutions per minute, and that they register accumulating revolutions.

(c) *Engine temperature gages.* Observe engine temperature gages to determine whether or not they are functioning. Engine temperature should increase gradually to operating range of 160° to 210° F. Maximum safe operating temperature is 240° F.

(d) *Ammeter.* The ammeter should register zero or slight discharge (—) with the engines idling, or register zero or slight positive (+) charge with engines running at approximately 1,400 revolutions per minute. Any unusual drop or rise in reading should be investigated. A high-charge reading, for an extended period, may indicate a dangerously low battery or a faulty generator regulator.

(8) *Item 10, Siren.* Test siren, unless tactical situation prohibits, for proper operation and tone.

(9) *Item 12, Lamps (lights) and reflectors.* If tactical situation permits, turn on all switches to determine that all lamps respond. See that lamps are secure and that lenses are clean and not broken.

(10) *Item 14, Tracks.* Inspect tracks, track wheels, support rollers, and sprockets for damage which may have occurred since last inspection.

tion. Look for loose screws, improper track tension (par. 143), and for any foreign matter in suspension linkage.

(11) *Item 15, Springs and suspensions.* Look for broken, loose, or damaged suspension arms, shocks, track wheels, compensating wheels, and linkage. See that track wheel, compensating wheel and support roller bolts, nuts and cap screws are present and secure.

(12) *Item 16, Steering brake linkage.* Inspect all steering brake lever linkage to determine that it is in condition for safe operation. Pull back on both pairs of steering levers (assistant driver's and driver's) and observe whether or not both meet firm resistance at 6 to 8 notches of lever travel. Check to determine that lever locking devices hold properly.

(13) *Item 17, Fenders.* Inspect fenders and sand shields to make sure that they are in good condition, secure, and do not interfere with tracks.

(14) *Item 36, Guns: Mountings, elevating, traversing, stabilizer, and firing controls. Spade, winch, and platform.* Test manual traversing and gun elevating controls and operation of firing controls to be sure that all mechanisms respond properly. Inspect spade, winch, and platform and test for proper operation. Return spade and platform to traveling position and make sure spade is properly secured.

(15) *Item 18, Towing connections.* See that the four towing shackles are in good condition and secure.

(16) *Item 20, Decontaminator.* Examine decontamination unit for tight mounting, full charge, and closed valve.

(17) *Item 21, Tools, parts, and accessories.* Make sure that tools, parts, and accessories belonging to vehicle are present, serviceable, and properly mounted or stowed.

(18) *Item 22, Engine operation.* Engines should idle smoothly at 450 revolutions per minute. Accelerate engines several times after they have reached normal operating temperature (160° to 180° F.) and note any unusual noises, or faulty operating characteristics.

(19) *Item 23, Driver's permit and Form No. 26.* Driver must have operator's permit on his person. See that Accident-Report Form No. 26, Lubrication Order, Operator's Manuals, and Form No. 478, are present, legible, and safely stowed.

### **37. During-Operation Service**

a. **OBSERVATIONS.** While the vehicle is in motion, listen for rattles, knocks, squeals, or hums that may indicate trouble. Look for indications of trouble in cooling system and for smoke from any part of the vehicle. Be on the alert to detect any odor of overheated components or units such as generators or brakes, vapor from a leak in fuel system, exhaust gas, or other signs of trouble. Each time the brakes are used,

or vehicle is turned, consider this a test and notice any unsatisfactory or unusual performance. Frequent checks of the instrument readings are necessary. Notice promptly any unusual instrument indications that may signify trouble in system to which the instrument applies.

*b. PROCEDURES.* During-operation Service consists of observing items listed below according to the procedures following each item and investigating any indications of serious trouble. Make note of minor deficiencies to be corrected or reported at earliest opportunity, usually at next scheduled halt.

(1) *Item 26, Steering brakes.* Vehicle should move straight when levers are in released position and levers should have a reasonably equal amount of travel and start to hold at approximately 6 to 8 notches from released position. Parking lever locks on driver's side should hold levers securely in applied position.

(2) *Item 29, Transmissions.* Vehicle should start satisfactorily from a standstill in either DRIVE or LOW range. Be on the alert for abnormal conditions in transmissions as indicated by excessive slippage and engine racing, unusually severe shifting, or shifting in wrong speed ranges.

(3) *Item 30, Transfer unit.* Be on the alert for unusual conditions in the transfer unit, such as hard shifting, gear clash, or jumping out of gear.

(4) *Item 31, Engine and controls.* Driver should be on the alert for deficiencies in engine performance such as lack of usual power, misfiring, unusual noises, or indications of overheating. Observe whether or not engines accelerate satisfactorily and controls operate freely. If radio noise during operation of the engine is reported, the driver will cooperate with the radio operator in locating the interference.

(5) *Item 32, Instruments.* Observe readings of all instruments frequently during operation to see whether or not they are operating properly to indicate or record the proper function of the units to which they apply. Also see if speedometer indicates vehicle speed in miles per hour and records accumulating mileage.

(6) *Item 34, Running gear.* Listen for any unusual noise from tracks, suspension wheels, and rollers.

### **38. At-Halt Service**

*a. IMPORTANCE.* At-halt Services may be regarded as minimum maintenance procedures and should be performed under all tactical conditions, even though more extensive maintenance services must be slighted or omitted altogether.

*b. PROCEDURES.* At-halt Service consists of investigating any deficiencies noted during operation, inspecting items listed below accord-

ing to the procedures following the items, and correcting any deficiencies found. Deficiencies not corrected should be reported promptly to the designated individual in authority.

(1) *Item 38, Fuel, oil, and water.* Check fuel supply to see that it is adequate to operate vehicle to next refueling point. Check oil level in engines and add oil if necessary. Check coolant supply in each cooling system and add clean water as necessary. In freezing weather, antifreeze of proper strength should be added if considerable coolant is needed.

**Caution:** Be sure to vent pressure radiator caps before removing, to avoid serious injury from steam and hot water.

(2) *Item 39, Temperatures: Hubs, transfer unit, differential, and final drives.* Place hand on each wheel and track support roller hub to determine whether or not they are abnormally hot. If hubs are too hot to touch with the hand, bearings may be inadequately lubricated, damaged, or improperly adjusted. Examine transfer case, differential, and final drives for excessive heat and leakage. Examine shock absorbers for heat; a cold shock absorber is not operating.

(3) *Item 42, Suspension.* Look for broken, loose, or damaged suspension arms, linkage, shocks, track wheels, rollers, and compensating wheels. Inspect to determine if suspension wheel, compensating wheel and support roller bolts, nuts, and cap screws are present and secure.

(4) *Item 43, Steering brakes.* Examine steering brake linkage for damage or looseness and investigate any irregularities noted during operation.

(5) *Item 45, Tracks.* Examine tracks and wheel tires to see that they are secure, not damaged, and that track tension is satisfactory (par. 144). Remove stones and trash from tracks and suspension system.

(6) *Item 46, Leaks—General.* Look around and under vehicle and in engine compartment for indications of fuel, oil, or coolant leaks.

(7) *Item 48, Air cleaners.* If operating under extremely dusty or sandy conditions, inspect air cleaners at each halt, to see that they are in condition to deliver clean air properly. Service as required.

(8) *Item 49, Fenders.* Examine fenders and sand shields to see that they are secure and in good condition.

(9) *Item 50, Towing connections.* Examine towing shackles to see that they are securely fastened. Examine towing cable for frayed or broken condition. Make sure that cable is mounted securely when not in use.

(10) *Item 51, Hull and camouflage net.* Inspect hull of vehicle for damage. Inspect camouflage net to see that it is properly secured and not damaged.

(11) *Item 52, Glass.* Clean glass in vision devices and lights, and inspect for damage.

### 39. After-Operation and Weekly Services

a. **PURPOSE.** After-operation Service is particularly important because at this time the driver inspects his vehicle to detect any deficiencies that may have developed, and corrects those he is permitted to handle. He should report promptly to the designated individual in authority the results of his inspections. If this schedule is performed thoroughly, the vehicle should be ready to roll again on a moment's notice. The Before-operation Service, with a few exceptions, is then necessary only to ascertain whether or not the vehicle is in the same condition in which it was left, upon completion of the After-operation Service. The After-operation Service should never be entirely omitted, even in extreme tactical situations, but may be reduced to the bare fundamental services outlined for the At-halt Service if necessary.

b. **PROCEDURES.** When performing the After-operation Service, the driver must remember and consider any irregularities noticed during the day, and in the Before-operation, During-operation, and At-halt Services. The After-operation Service consists of inspecting and servicing the following items. Those items of the After-operation Service that are marked by an asterisk (\*) require additional weekly services, the procedures for which are indicated in subparagraph (b) of each applicable item.

(1) *Item 54, Fuel, oil and water.* Fill both fuel tanks. Check all level in engines and, if necessary, add oil to FULL mark on gage. Inspect level of coolant in both radiators and add as required, using antifreeze compound in freezing weather. If oil or water use is excessive, investigate cause.

(2) *Item 55, Engine operation.* Before stopping engine, accelerate and decelerate noting any unusual noise or irregular performance. Investigate any deficiencies noted during operation.

(3) *Item 56, Instruments.* Inspect all instruments to see that they are securely mounted, properly connected, and not damaged. Also see that they indicate or record the proper function of the units to which they apply.

**Caution:** Be sure to vent pressure radiator caps before removing to avoid serious injury from steam and hot water.

(4) *Item 57, Siren.* If tactical conditions permit, test siren operation and tone.

(5) *Item 58, Glass.* Clean all vision devices and glass and inspect for damage.

(6) *Item 59, Lights.* Clean all light lenses. Examine for broken parts and security of mounting. If tactical situation permits, open and close all switches and see that all lights respond properly.

(7) *Item 60, Fire extinguishers.* Inspect fixed fire extinguisher for tight mounting, damage, and leakage of valves or lines. Inspect

nozzles for proper aim, damage, and security of mountings and connections. Be sure wire seals are present and intact. Inspect portable extinguishers for good condition and security. See that wire is present and intact. Be sure nozzles are not clogged.

(8) *Item 61, Decontaminator.* Inspect decontaminator for full content, damage, and security of mounting. Remove filler plug to check contents.

(9) *Item 62, \*Battery.* (a) Inspect battery for damage or leakage and security of mountings and connections. Top of battery, cables, terminals, and vent caps must be clean.

(b) *Weekly.* Add distilled water as necessary to bring electrolyte level one-half inch above top of plates. If distilled water is not available, any clean water is preferable to allowing cells to run dry.

*Note.* In low temperatures, do not add water until vehicle is about to be operated. Clean and tighten terminals if loose or dirty, and give them a light coating of grease.

(10) *Item 63, Accessories and belts.* Open engine compartment door and inspect all accessible accessories for looseness and damage. Be sure fan and generator belts are in good condition and belt tension is  $\frac{5}{8}$ - to  $\frac{3}{4}$ -inch, finger-pressure deflection between pulleys.

(11) *Item 64, \*Electrical wiring.* (a) Examine all accessible wiring conduits to see that they are properly connected and supported to hull.

(b) *Weekly.* Tighten all radio noise suppressor bond straps and accessible capacitor mountings and connections, and be sure suppressor units are secure.

(12) *Item 65, Air cleaners, breathers, and vents.* Inspect carburetor air cleaners and crankcase ventilator air cleaners for good condition and security of mountings. Inspect condition of oil and filter element. Clean and service if excessive dirt is present according to lubrication order (par. 33).

(13) *Item 67, Engine controls.* Inspect accelerator and hand throttle controls for security, damage, excessive wear, and free operation.

(14) *Item 68, Tracks.* Examine tracks for damage, excessive looseness, broken or missing connectors. Inspect track tension (par. 143). Adjust if necessary.

(15) *Item 69, \*Suspension.* (a) Inspect suspension arms and compensating linkage for looseness or damage. Remove any foreign objects embedded in the tracks or between the wheels, sprockets, and suspension arms. Examine rubber tires for cuts, breaks, or separation from wheels. Be sure shock absorbers are secure and not leaking.

(b) *Weekly.* Tighten suspension assembly bolts, cap screws, and nuts and see that all securing wires or cotter pins are present and in good condition. Inspect guides, support rollers, compensating wheels, and sprockets for excessive wear or damage.

(16) *Item 70, Steering brakes.* Inspect brake levers for secure mounting, and linkage for excessive wear or damage and for free operation and secure holding of locking pawls. Investigate or report any deficiencies noticed during operation.

(17) *Item 73, Leaks.* Examine area beneath vehicle and floor of driving and engine compartments for oil, fuel, or coolant leakage.

(18) *Item 74, Gear oil levels.* Check level of oil in transmissions, transfer unit and final drive housings and fill to proper level. Report any abnormal usage.

**Caution:** In checking transmission level, be sure to use correct procedure (par. 33).

(19) *Item 76, Fenders.* Examine fenders and dust shields to see that they are in good condition and secure.

(20) *Item 77, Towing connections.* Examine the four towing shackles and pintle hooks to see that they are present, in good condition, and securely attached.

(21) *Item 78, Hull.* Examine entire hull for damage from shellfire or collision. Inspect doors over driving compartment for good condition and proper operation of hinges and latches.

(22) *Item 80, Vision devices.* Inspect the periscope prisms and windows to see that they are in good condition, clean, secure in the holders, and that the holders are securely mounted. Inspect the spare periscope and their storage boxes to see that they are in good condition, clean, and secure.

**Caution:** Periscopes should be cleaned with a soft cloth or brush only.

(23) *Item 81, Howitzer and mount. Winch, spade, and platform.* Be sure that howitzer is secure in mount, clean, lightly oiled, and in condition for immediate use. Test manual howitzer elevating mechanisms and firing controls for proper operation. Check level of oil in elevating gear case. Be sure all exposed wiring is secure and undamaged. Examine packing glands, oil lines, piston and cylinder assembly, and drain plugs for leaks. Determine if manual traversing and electric and manual elevating mechanisms are in good condition and operate satisfactorily. Inspect winch and test for operation. Determine if cable is in good condition. Inspect spade and platform. Check hinges and fastenings. Determine if spade and platform are in good condition and operate satisfactorily.

(24) *Item 82, \*Tighten.* (a) Tighten all items which require tightening as indicated by inspection.

(b) *Weekly.* Tighten the following: Gun mounting attachments, tools and equipment mounted on vehicle, ammunition cases, or any other units which require tightening on a weekly or mileage basis as indicated by inspection or experience.



(25) *Item 83, \*Lubrication (weekly only)*. Lubricate all points which vehicle lubrication order indicates are necessary on a weekly or mileage basis, or any points which need additional lubrication as indicated by condition and experience.

(26) *Item 84, \*Cleaning*. (a) Remove all empty shell cases and refuse from gun mount. Clean all oil from driving compartment and floor of vehicle. Remove excessive mud and dirt from tracks and suspension system. See that grilles are not obstructed. Open bulkhead doors and clean radiator core air passages, if necessary.

(b) *Weekly*. Wash exterior of vehicle and remove all dirt and mud. If washing is impracticable, wipe as clean as possible and watch for bright spots that would cause glare. Wipe out all excess dirt, fuel, oil, or coolant drippings from engine compartment.

(27) *Item 85, \*Tools and equipment*. (a) See that tools and equipment assigned to vehicle are present, in good condition, and properly stowed, or mounted.

(b) *Weekly*. Clean all tools and equipment. See that tools and equipment are in serviceable condition and that tools with cutting edges are sharp and properly protected. Properly mount or stow all items.

#### **40. Battery Maintenance (Second Echelon)**

a. **FREQUENCY**. The frequency of the preventive maintenance services outlined herein is considered a minimum requirement for normal operation of vehicle. Under unusual operating conditions such as extreme temperatures, dust or sand, or extremely wet terrain, it may be necessary to perform certain maintenance services more frequently.

b. **FIRST ECHELON PARTICIPATION**. The drivers should accompany their vehicles and assist the mechanics while periodic second echelon preventive maintenance services are performed. Ordinarily the driver should present the vehicle for a scheduled preventive maintenance service in a reasonably clean condition; that is, it should be dry and not caked with mud or grease to such an extent that inspection and servicing will be seriously hampered. However, the vehicles should not be washed or wiped thoroughly clean, since certain types of defects, such as cracks, leaks, and loose or shifted parts or assemblies are more evident if the surfaces are slightly soiled or dusty.

c. If instructions other than those contained in the general procedures in step (d) or the specific procedures in step (i) which follow are required for the correct performance of a preventive maintenance service or for correction of a deficiency, other sections of this manual pertaining to the item involved, or a designated individual in authority, should be consulted.

*d. GENERAL PROCEDURES.* These general procedures are basic instructions which are to be followed when performing the services on the items listed in the specific procedures.

*Note.* The battery maintenance personnel must be thoroughly trained in these procedures so that they will apply them automatically.

(1) When new or rebuilt subassemblies are installed to correct deficiencies, care should be taken to see that they are clean, correctly installed, properly lubricated, and adjusted.

(2) When installing new lubricant retainer seals, a coating of the lubricant should be wiped over the sealing surface of the lip of the seal. When the new seal is a leather seal, it should be soaked in warm engine oil (OE 10) if practicable for at least 30 minutes. Then, the leather lip should be worked carefully by hand before installing the seal. The lip must not be scratched or marred. Caution must be exercised to insure installation of lip of seal in proper direction.

*e. DEFINITION OF TERMS.* Refer to paragraph 34b.

*f. SPECIAL SERVICES.* These are indicated by repeating the item numbers in the columns which show the interval at which the services are to be performed, and show that the parts or assemblies are to receive certain mandatory services. For example, an item number in one or both columns opposite a "Tighten" procedure means that the actual tightening of the object must be performed. The special services include the following:

(1) *Adjust.* Make all necessary adjustments in accordance with the pertinent section of this manual, special bulletins, or other current directives.

(2) *Clean.* Clean units of the vehicle with dry-cleaning solvent to remove excess lubricant, dirt, and other foreign matter. After the parts are cleaned, rinse them in clean solvent and dry them thoroughly. Take care to keep the parts clean until reassembled and be certain to keep dry-cleaning solvent away from rubber or other material which it will damage. Clean the protective grease-coating from new parts since this material is usually not a good lubricant.

(3) *Special lubrication.* This applies either to lubrication operations that do not appear on the vehicle-lubrication order or to items that do not appear on such orders, but which should be performed in connection with the maintenance operations if parts have to be disassembled for inspection or service.

(4) *Serve.* This usually consists of performing special operations, such as replenishing battery water, draining, and refilling units with oil and changing or cleaning the oil filter, air cleaner, or cartridges.

(5) *Tighten.* All tightening operations should be performed with sufficient wrench torque (force on the wrench handle) to tighten the

unit according to good mechanical practice. Use a torque-indicating wrench where specified. Do not overtighten, as this may strip threads or cause distortion. Tightening will always be understood to include the correct installation of lock washers, lock nuts, lock wire, or cotter pins provided to secure the tightening.

*g. SPECIAL CONDITIONS.* When conditions make it difficult to perform the complete preventive maintenance procedure at one time, they can sometimes be handled in sections, planning to complete all operations within the week if possible. All available time at halts and in bivouac areas must be utilized, if necessary, to assure that maintenance operations are completed. When limited by the tactical situation, items with Special Services in the columns should be given first consideration.

*h. WORK SHEET.* The numbers of the preventive maintenance procedures that follow are identical with those outlined on WD AGO Form No. 462, which is the "Preventive Maintenance Service Work Sheet for Full-track and Tank-like Wheeled Vehicles." Certain items on the work sheet that do not apply to this vehicle are not included in the procedures in the manual. In general, the numerical sequence of items on the work sheet is followed in the manual procedures, but in some instances there is deviation for conservation of the mechanic's time and effort.

*i. SPECIFIC PROCEDURES.* The procedures for performing each item in the semimonthly and monthly maintenance procedures whichever shall occur first, are described in the following road-test chart. Each page of the chart has two columns at its left edge corresponding to the monthly and the semimonthly maintenance respectively. See WD Circular No. 36. Very often it will be found that a particular procedure does not apply to both scheduled maintenances. In order to determine which procedure to follow, look down the column corresponding to the maintenance due and wherever an item number appears, perform the operation indicated opposite the number.

*Note.* Those procedures preceded by an asterisk (\*) require additional services at each third monthly service.

## ROAD TEST

### MAINTENANCE Monthly Semimonthly

*Note.* Those procedures preceded by an asterisk (\*) require additional road test, perform items 2, 3, 5, 9, 12, 13, and 15 which require little or no movement of the vehicle. When a road test is possible, it should be for preferably 3 and not over 5 miles.

### Before-Operation Service

- |   |   |  |
|---|---|--|
| 1 | 1 | Perform the Before-operation Service outlined in paragraph 36. |
|---|---|--|

## **ROAD TEST—Continued**

### **Instruments and Gages**

- 2      2      Observe readings of all instruments frequently during operation to see whether they are indicating properly.

**OIL-PRESSURE WARNING SIGNAL.** In case of lighting of oil-pressure warning signal, vehicle should be stopped immediately and trouble corrected or reported to proper authority.

**ENGINE TEMPERATURE GAGES.** Engine temperatures should rise gradually to normal range, 160° to 210° F., and gage should always indicate below 240° F. If gage indicates more than this, or if warning signal lights, stop vehicle until correction can be made.

**AMMETER.** The ammeter will register zero or slight discharge (−) with the engines idling, or register zero or slight positive charge (+) with engines running at operating speeds. Any unusual drop or rise in reading for an extended period may indicate a dangerously low battery or a faulty generator regulator.

**TACHOMETERS.** Tachometers should indicate engine speed and accumulating revolutions without excessive noise or fluctuation.

**SPEEDOMETER AND ODOMETER.** Speedometer should indicate vehicle speed. Odometer should register accumulating mileage without excessive noise or fluctuation.

**WARNING LIGHTS.** Transmission oil pressure warning lights should be off when engines are running faster than 450 revolutions per minute. Lights may flicker at slow idle speed.

### **Windshield, Windshield Wipers, and Siren**

- 3      3      Inspect windshield assembly and wipers (when in use) to see that they are in good condition, secure, and whether or not wiper blades move through their full stroke and contact surface evenly. Inspect siren for good condition and secure mounting and, if tactical situation permits, test for operation and tone.

## ROAD TEST—Continued

### Brakes (Steering)

- 5            5     With vehicle stopped, pull back on steering brake levers; if brakes are properly adjusted, levers should start to take hold at 6 to 8 notches of travel on ratchet. Accelerate vehicle to a moderate speed, release accelerator, apply both steering brakes, and observe whether or not they stop the vehicle effectively. Apply steering brakes independently, and see that they steer vehicle properly. Apply parking brake with vehicle on reasonable incline. It should hold vehicle effectively, and locking device should hold levers in applied position.

### Transmission (Lever Action, Vibration, and Noise)

- 7            7     Operate vehicle through each speed range of transmission. Observe whether or not selector lever operates properly and whether or not there are any unusual vibrations or noises in any speed range that might indicate damage, excessive wear, loose mountings, or improper operation.

### Engine (Idle, Acceleration, Power, Noise, Smoke, and Oil Consumption)

- 9            9     **IDLE.** With the vehicle stopped, observe if engines run smoothly at normal idling speed, 450 revolutions per minute. Throughout road test, observe if there is any tendency of engines to stall when accelerator is released and hand throttle closed.

**ACCELERATION, POWER, VIBRATION, AND NOISE.** Test engines for normal acceleration and pulling power in each speed. While testing in driving range, accelerate from low speed with wide-open throttle up to top speed and listen for unusual engine noise, knock, whine, or vibration that might indicate loose, damaged, excessively worn, or inadequately lubricated engine parts or accessories, or loose mountings or drive belts.

**SMOKE.** During operation, observe if there is excessive smoke from exhaust.

**OIL CONSUMPTION.** Upon completion of road test, a check should be made to determine whether or not either or both engines have been consuming an excessive amount of oil.

## ROAD TEST—Continued

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| 10 | 10 | UNUSUAL NOISES (PROPELLER SHAFTS AND UNIVERSAL JOINTS, DIFFERENTIAL AND FINAL DRIVES, SPROCKETS, WHEELS, SUPPORT ROLLERS, AND TRACKS). During road test, listen for any unusual noise from these units, indicating damaged, defective or loose parts, or inadequate lubrication.  |
| 11 | 11 | TEMPERATURES (TRANSMISSION, TRANSFER UNIT, DIFFERENTIAL, AND FINAL DRIVES, HUBS, SPROCKETS, WHEELS, AND SUPPORT ROLLERS). After operating, remove bottom inspection plate and examine transmissions for excessive heat. Check by hand-feel for any abnormal temperature in transfer unit, differential and final drives, hubs of sprockets, wheels, and support rollers.<br><br><i>Note.</i> If location on grade is selected for this check, time will be saved in performing item 12. |
| 12 | 12 | GUN ELEVATING AND TRAVERSING MECHANISM. Place vehicle in a position where it will be tilted (sidewise) about 10°. Traverse gun mount through its full range, by hand controls, checking for indication of binding. With howitzer pointed forward, elevate it through its entire range with hand controls; check for binding, excessive lash, or erratic action.   |
| 13 | 13 | LEAKS. Look in engine compartment, and also beneath vehicle, for indications of fuel, oil, or coolant leaks.  |
| 15 | 15 | TRACK TENSION; FINAL ROAD TEST. Inspect for satisfactory track tension after final road test (par. 143), and adjust if necessary.   |

## MAINTENANCE OPERATIONS

### Engine Crankcase (Leaks and Level)

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| 17 | 17 | Observe both crankcases for indications of oil leaks, and inspect bayonet gages for oil level. Add oil as necessary. If oil change is due or condition of oil warrants a change, drain and refill crankcases to proper level with specified oil. See lubrication order, paragraph 33. |
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*Note.* If oil is changed, do not start engines until new oil filter elements have been installed as in item 54.

## ROAD TEST—Continued

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| 54 | 54 | ENGINE OIL FILTERS. Inspect oil filters to see that they are in good condition, secure, and not leaking. Drain off accumulated sediment from filter bowl.  |
| 54 |    | CLEAN AND SERVE. Remove oil filter elements, clean cases, and install new filter elements, using new gaskets and tightening covers securely. See lubrication order, paragraph 32.  |
| 18 | 18 | SIDE ARMOR (FENDERS, DUST SHIELDS, GUARDS, PAINT AND MARKINGS, SHACKLES, AND SIREN). Inspect these items to see that they are in good condition, that armor, fenders, dust shields (if so equipped), guards, shackles, and siren are secure and that towing shackles are not excessively worn. Observe condition of paint for rust or polished surfaces that may cause reflections, and (unless covered for tactical reasons) see that all vehicle markings are legible. |
| 19 | 19 | BOTTOM (ARMOR, INSPECTION PLATES, AND DRAIN PLUGS). See that these items are in good condition and secure, and that bottom drain plugs are tight. Tighten all bottom inspection plates securely.   |
| 20 | 20 | DIFFERENTIAL AND FINAL DRIVES. Inspect housings for good condition and leakage; check lubricant level. See that all assembly and mounting bolts are secure. If change of lubricant is due, or condition of oil warrants a change, drain and refill with specified oil at this time. See lubrication order, paragraph 32.   |
| 20 |    | TIGHTEN. Tighten all external assembly and mounting bolts securely.  |
| 21 | 21 | TRACKS (SHOES, SHOE PINS, AND BUSHINGS). Inspect tracks to see that these items are in good condition, correctly assembled, secure, and not excessively worn. Tighten track screws to 80 to 90 foot-pounds.  |

### \*Note:

21. Whenever the tracks are disconnected and removed from the sprockets, support rollers, and wheels, or at each third monthly maintenance service, the related items 22 and 25 marked on the Preventive Maintenance Service Work Sheet WD, AGO Form 462 should be inspected as described below in the asterisk-marked (\*) procedures. On the regular semimonthly and monthly maintenance services, the tracks should not be removed unless repairs are needed.

## ROAD TEST—Continued

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**Caution:** Whenever tracks are removed for repair or replacement, do not reinstall tracks until the services followed by the asterisk (\*) in items 22 and 25 have been completed.

- 22        22        COMPENSATING (WHEELS, ARMS, ADJUSTMENT, LOCK NUTS). Inspect these items to see that they are in good condition, correctly assembled, secure, and that grease is not leaking excessively from wheel bearing seals. Be sure adjusting nuts and adjusting locks are secure. Tighten all assembly and mounting bolts and nuts securely.

**\*Note:**

- 22        In addition to the above, at each third monthly maintenance service or whenever the tracks are removed, check the compensating wheel hub bearings for looseness or end play. Spin the wheels and listen for any unusual noise that might indicate a damaged, excessively worn, or inadequately lubricated bearing.
- 23        23        BOGIE (ARMS, SHOCK ABSORBERS, LINKS, BRACKETS). Examine above components to see if they are in good condition, correctly assembled, securely mounted, and not excessively worn. Inspect shock absorbers for leaks.
- 23        TIGHTEN. Draw up all suspension unit assembly or mounting nuts or screws securely.
- 24        24        WHEELS (TIRES, SUPPORT ROLLERS). Inspect wheels and rollers for good condition, correct assembly, and secure mounting. Pay particular attention to see that tire rubber has not separated from rim and that tires are not cut, torn, or excessively worn. Inspect for excessive lubricant leaks from bearings.
- 24        TIGHTEN. Jack up track wheels and test bearings for looseness, roughness, and end play. Spin wheels and listen for any unusual noise. Tighten assembly and mounting bolts securely.
- 24        *Note.* Whenever the tracks are removed, the above operation should be performed before the tracks are reinstalled.
- 25        25        SPROCKETS (HUBS, TEETH, AND NUTS). Inspect sprockets for good condition, correct assembly, and security of mounting bolts. Inspect sprocket teeth for excessive wear, and shaft flange gaskets or oil seals for excessive leaking of lubricant. If sprocket teeth



## ROAD TEST—Continued

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are excessively worn, sprockets should be replaced or reversed. Tighten assembly and mounting bolts securely.

- 25      *Note.* In addition to the above, at each third monthly operation, or whenever the track is disconnected and removed from the sprocket, check the sprocket teeth for excessive wear, see that sprockets are well secured to hubs and that the hub-to-final drive bolts are secure. Check the sprocket hub bearings for looseness and end play. After performing the above, reinstall the tracks and connect them securely.

- 26      26      **TRACK TENSION.** Adjust track to standard tension (par. 143).

- 27      27      **TOP ARMOR, HULL, DECK, PAINT AND MARKINGS, GRILLES, DOORS, LATCHES, AND ANTENNA MAST.** Inspect these items to see that they are in good condition and secure. See that door hinges and latches operate properly, are not excessively worn, and are adequately lubricated. Be sure grilles are not obstructed. Examine paint for rust spots or polished surfaces that may cause reflections and, unless covered for tactical reasons, see that vehicle markings are legible.

- 28      28      **CAPS AND GASKETS (FUEL AND RADIATOR).** Inspect to see that fuel tank and radiator caps and gaskets are in good condition, secure, and not leaking.

- 30      **ENGINE REMOVAL (WHEN REQUIRED).**

**SERVE.** Remove engines on monthly maintenance service only if inspections made in items 9, 10, 13 and a check of oil consumption indicate a definite need.

- 30      30      **CLEAN.** Clean exterior of engine and dry thoroughly, taking care to keep dry-cleaning solvent away from electrical wiring, terminal boxes, and equipment.

*Note.* In this and following services (items 32 to 60), the procedures should be followed in the best possible manner if engines are not removed from vehicle.

- 32      **SPARK PLUGS (GAPS AND DEPOSITS).** Remove and clean spark plugs. Inspect insulators for cracks or breaks and electrodes for excessive burning. Replace unserviceable plugs with new or reconditioned plugs. Adjust electrodes of all plugs to be installed to 0.030 inch by bending grounded electrodes. Be sure to install new gaskets and do not overtighten plugs.

*Note.* Perform item 33 before reinstalling plugs. Inspect the spark plug resistor-suppressors for scorching and cracks and be sure all connections are secure.

## **ROAD TEST—Continued**

**COMPRESSION TEST (RECORD).** When spark plugs are removed for performance of item 32, test compression of each cylinder and record gage readings on WD AGO Form No. 462. If there is more than 10 pounds variation between cylinders, report to designated authority.

34      34      **GENERATORS AND STARTERS.** Inspect generators and starters for good condition, security of mounting, and secure wiring connections. Remove commutator inspection covers and examine commutator for good condition. See that brushes are free in brush holders, clean and not excessively worn, that brush connections are secure, and that wires are not broken or chafing. Clean commutator end of units by blowing out with compressed air. Tighten mounting bolts securely. Inspect generator armature brush capacitors to see that they are in good condition and securely connected.

36      36      **DISTRIBUTORS.** Inspect distributor bodies and external attachments and radio noise resistor-suppressors for good condition and secure mountings. Clean caps, rotors, and seals, and inspect for good condition and correct assembly. Look for cracks or burns. Inspect breaker points for good condition, good alignment, and a 0.015-inch gap. If the breaker plate assemblies are unserviceably dirty, remove the distributor, clean in dry-cleaning solvent, dry with compressed air, lubricate the parts as specified below for the monthly maintenance service, and reinstall the distributors in correct position for timing. When cleaning distributors, remove wicks and lubrication cups, clean, and dry while removed and reinstall them only after the distributor assemblies are cleaned and blown dry with compressed air. If the breaker points are pitted, burned, or worn to an unserviceable condition, install a new set. If points are badly pitted, test condenser connections for tightness, and if tight replace condenser also. If points are slightly pitted or burned, dress with point file or 2/0 flint paper and blow off filings with compressed air.

**SHAFT.** Check shafts by hand-feel for looseness to determine whether or not the bushings are worn.

**CENTRIFUGAL ADVANCE.** Test range of movement of centrifugal advance mechanism by rotating shaft

## ROAD TEST—Continued

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- and rotor by finger force. Observe whether or not shaft returns to original position without binding.
- 36      **SPECIAL LUBRICATION.** Lubricate cam surfaces, movable breaker-arm pin and camshaft sparingly with general-purpose grease, and the wick with a few drops of engine oil (OE 10).
- Note.* Keep lubricant off the distributor points; do not apply more lubricant than is specified; and wipe the cam clean before lubricating its surface.
- See lubrication order, paragraph 32.
- 36      **ADJUST.** Adjust breaker-point gap to 0.015 inch at wide-open position.
- 38      38      **IGNITION WIRING AND CONDUITS.** Inspect accessible ignition wiring and conduits for cleanliness, good condition, correct assembly, secure mounting, and see that they are not chafing against other engine parts.
- 39      39      **COILS.** Inspect ignition coils and radio noise suppressor capacitors and be sure they are clean and that all mountings and connections are secure.
- 42      42      **BREATHING CAPS AND VENTILATORS.** Inspect engine crankcase ventilator oil bath air cleaner for good condition and correct assembly. Clean oil bath air cleaner, recoil and reinstall securely. See lubrication order, paragraph 32.
- 43      43      **AIR CLEANERS (CARBURETORS).** Disassemble, clean, recoil, and reinstall carburetor air cleaners following carefully the correct procedure outlined in lubrication order, paragraph 32.
- 44      44      **CARBURETORS (AUTOMATIC CHOKES, THROTTLES, LINKAGE).** Inspect these items to see if they are in good condition, correctly assembled, and securely installed; that carburetors do not leak; that control linkage, automatic choke, and throttle shafts are not excessively worn. Inspect automatic chokes for closed position when engine is cool. See that throttle valves open fully when accelerator is fully depressed. Remove the fuel cleaner strainer from each carburetor fuel inlet, clean in dry cleaning solvent, and reinstall. Tighten knurled nut finger-tight; do not use pliers.
- 45      45      **MANIFOLDS (INTAKE AND EXHAUST).** Inspect accessible portions of manifolds for good condition, secure mountings, and for possible leaks.

## ROAD TEST—Continued

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- 45            **TIGHTEN.** Tighten manifold assembly mounting nuts and cap screws to 25–30 foot-pounds torque.
- 46            46        **CYLINDER (HEADS AND GASKETS).** Inspect cylinder heads for good condition and secure mounting. Note any indications of oil, coolant, or compression leakage around cap screws or gaskets.
- Caution:** Cylinder-head cap screws should not be tightened unless there is a definite indication of looseness or leaks. If tightening is necessary, a torque-indicating wrench must be used and screws tightened in proper sequence (fig. 51) to 70–75 foot-pounds.
- 49            49        **WATER PUMPS, FANS, AND SHROUDS.** Observe whether or not these items are in good condition and securely mounted. Be sure fan blades do not interfere with shrouds or cores. See that the drive belts and pulleys are well aligned; belts not excessively worn, frayed, oil soaked, improperly adjusted, or bottoming in drive pulleys. Adjust to  $\frac{5}{8}$ - to  $\frac{3}{4}$ -inch finger-pressure deflection.
- 51            51        **ENGINE COMPARTMENT (BULKHEAD AND CONTROL LINKAGE).** See that engine compartment including bulkhead is in good condition, clean, and secure; and that control linkage in the engine compartment is in good condition, and securely connected and mounted.
- 51                        **CLEAN.** Clean engine compartment as thoroughly as possible. Whenever engines are removed, clean out all fuel and oil drippings, dirt, and refuse; wipe out the engine compartment with cloths soaked in dry cleaning solvent, and dry thoroughly.
- 53            53        **FUEL (TANKS AND LINES).** Inspect accessible portion of these items for correct assembly, good condition, and secure mounting. Note whether or not there are indications of fuel leaks from tanks or lines. Drain water and sediment from each tank by removing drain plugs and allowing fuel to drain briefly until it runs clean. Tighten plugs and fuel tank drain-hole cover securely to prevent fuel and dust leaks.

**Caution:** Catch drainings in container and use every precaution not to spill fuel. If fuel does spill, wipe up until dry before turning on the main battery switch.

## ROAD TEST—Continued

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- 53 TIGHTEN. Tighten accessible fuel line support clips securely.
- 56 56 OIL COOLERS (TRANSMISSION AND DIFFERENTIAL). Examine differential oil cooler and lines, and transmission coolant lines for good condition, secure attachment and for leaks. Inspect differential oil cooler to see that core is not clogged with dirt and trash; clean out foreign material.
- 57 57 EXHAUST PIPES AND MUFFLERS. Inspect these items for good condition, secure assembly, and mounting of exhaust pipes and mufflers and for indications of exhaust leaks.
- 57 TIGHTEN. Tighten all accessible mounting bolts and connections securely.
- 58 58 ENGINE MOUNTINGS. Inspect all engine mountings and radio bond straps to see that they are in good condition and secure.
- 58 TIGHTEN. Tighten all mountings and brackets securely. When engines are removed, tighten the mount-to-engine and bracket-to-hull bolts securely.
- 60 60 FIRE EXTINGUISHER SYSTEM (TANK, VALVE, LINES, NOZZLES, AND MOUNTINGS). Inspect cylinder and valve of fire extinguisher system for good condition, secure mounting, and full charge. Full charge may be observed by presence of intact wire seal, but can be positively determined only by weighing. Examine control cables to see that they are in good condition and free to operate at a moment's notice. See that all lines and nozzles are in good condition, securely mounted and connected, with nozzles properly aimed and not clogged. If dirty or corroded nozzles are found, disconnect main feed line and blow out cautiously with compressed air.

*Note.* Empty, or partially empty, cylinders should be reported for recharge or replacement immediately.

**Caution:** Do not drop, strike, or roughly handle extinguisher cylinder, nor expose to excessive heat.

**SPECIAL LUBRICATION.** Apply a few drops of oil to pulleys and guides through which control cables operate.

- 60 TIGHTEN. Tighten all assembly and mounting bolts and screws.

## **ROAD TEST—Continued**

61

**ENGINES (INSTALL MOUNTINGS, LINES AND FITTINGS, WIRING, CONTROL LINKAGE AND OIL SUPPLY).** Reinstall removed engines according to instructions in paragraph 68. Take care to tighten mountings securely and to connect properly all fuel, oil, and coolant lines, wiring, and control linkage which were disconnected when engine was removed. Adjust control linkage. Be sure to refill engine crankcase with specified oil.

62

62

**RADIATORS (CORE, MOUNTINGS, HOSE, ANTIFREEZE, AND RECORDS).** Inspect these items for good condition, correct assembly, and for leaks. See that radiator mountings and hose and tubing connections are secure. Clean insects and refuse from external air passages of cores. Remove radiator if necessary. Test strength of antifreeze if in use. Examine coolant to determine whether or not it is contaminated with rust, oil, or other foreign matter to the extent that the cooling system should be cleaned. If inspection indicates cleaning is necessary, proceed according to paragraph 115, and current directives regarding proper procedures, cleaner, neutralizer and inhibitor. Refill radiator with proper coolant. Do not fill to top but allow room for expansion. On radiators which are removed, perform this inspection partly while removed from the vehicle, and partly after replacement, as necessary to make the complete inspection properly.

**SERVE.** Reinstall all removed radiators. Take care to tighten mountings, and hose or tubing connections securely. Fill the cooling system afterward, adding antifreeze or inhibitor as required and recheck the cooling system for leaks.

63

63

**BATTERY (CABLES, HOLD-DOWNS, BATTERY COMPARTMENT, RECORD OF GRAVITY, AND VOLTAGE).** Inspect battery case for cracks and leaks. Clean top of battery. Inspect cables, terminals, bolts, posts, straps and hold-downs for good condition. Test specific gravity and voltage and record on WD AGO Form 462. Specific gravity reading below 1.225 indicates battery should be recharged or replaced. Electrolyte level should be above top of plates and may extend one-half inch above plates.

## ROAD TEST—Continued

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| 63 | <p><b>SERVE.</b> Perform high rate discharge test according to instructions for "condition" test which accompany test instrument. Cell variation should not be more than 30 percent.</p> <p><i>Note.</i> Specific gravity must be above 1.225 to make this test.</p>   |
| 63 | <p><b>CLEAN.</b> Clean entire exterior of battery and interior of battery box. Repaint box if corroded. Add distilled water to one-half inch above cell plates. Clean battery terminal, terminal bolts and nuts, and battery posts. Inspect bolts for serviceability and grease lightly. Tighten terminals and hold-downs carefully to avoid damage to battery.</p> <p><i>Note.</i> Close main battery switch and open fuel shut-off valve at this time.</p>   |
| 64 | <p><b>64 ACCELERATORS (LINKAGE AND DUAL-THROTTLE SYNCHRONIZATION).</b> See that accelerators and all of their connecting linkage are in good condition, and securely connected. Press the accelerators down fully to see whether or not the carburetor throttles open fully. Check synchronization of throttle linkage at each carburetor to see that throttle valves open and close together. After starting engines, test to see that throttles are so adjusted that, at idle speed (450 revolutions per minute), the variation between the two engines will be no more than 50 revolutions per minute and at 1,000 revolutions per minute there will be no more variation than 100 revolutions. Inspect throttle control linkage to see that it is properly adjusted.</p> |
| 64 | <p><b>ADJUST.</b> Adjust throttle control linkage (par. 110).</p>  |
| 65 | <p><b>65 STARTING MOTORS AND INSTRUMENTS.</b> Start engines, observing all starting precautions outlined in item 1. Note whether the general action of the starters is satisfactory, particularly whether or not the drives engage, operate properly without excessive noise, and have adequate cranking speed. Observe whether each engine starts readily. As soon as the engines start, observe whether or not all instruments operate properly, and particularly if the oil pressure signal and ammeter indications are satisfactory.</p>   |
| 67 | <p><b>67 IGNITION TIMING.</b> With engine running, determine whether or not ignition timing of each engine is cor-</p>   |

## ROAD TEST—Continued

rect, according to instructions (par. 73). Also observe whether or not automatic controls advance the spark as engine is accelerated gradually. When necessary, adjust ignition timing to specifications (par. 73), taking care to see that distributor is well secured when adjustment is complete.

**Caution:** Be sure that distributor timing is properly adjusted for efficient engine performance with grade of fuel being used.

68        68        **REGULATOR UNIT (CONNECTIONS, VOLTAGE, CURRENT, AND CUT-OUT).** See that regulator units and the radio noise suppression capacitors and bond straps are in good condition, and that mountings and connections are secure.

68        Connect low-voltage circuit tester to regulator and observe whether or not voltage regulator, current regulator, and cut-out control the generator output properly. Follow instructions in vehicle manual, or those which accompany test instrument.

**Caution:** Make test only after regulator has reached normal operating temperature.

69        69        **ENGINE IDLE.** Adjust engine mixture and throttle stop to obtain smooth operation at 450 revolutions per minute. See paragraph 110.

70        70        **THROTTLE SYNCHRONIZATION.** Depress accelerator slowly and observe whether or not tachometers of both engines indicate within 50 revolutions at 450 revolutions per minute and within 100 revolutions at 1,000 revolutions per minute. At the conclusion of this maintenance service, allow engines to cool properly by operating at 450 revolutions per minute from 3 to 4 minutes before stopping them.

71        71        **GUN MOUNT (PAINT, SEATS, STOWAGE BOXES, AMMUNITION BOXES, CLIPS, AND RACKS).** Inspect to see that these items are in good condition, and securely assembled and mounted; that mount is clean, and that paint is in satisfactory condition; that adjusting mechanism of seats operate properly, and are adequately lubricated. Pay particular attention to see that shell hangers and dividers are all present and properly installed in ammunition boxes.



## ROAD TEST—Continued

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| 73 | 73 | <p><b>PERISCOPES.</b> Examine periscope prisms and windows to see that they are in good condition, clean, secure in holders, and that holders are securely mounted; that lever and locking devices operate freely and are not excessively worn; that their traversing and elevating devices are free and not excessively worn. Examine spare periscopes and their stowage boxes to see that they are in good condition, clean, and secure.</p> <p><b>Caution:</b> Prisms should be cleaned only with a soft cloth or brush.</p> |
| 75 | 75 | <p><b>BRAKES (STEERING LEVERS, LINKAGE, AND SHAFTS).</b> Inspect steering brake levers, linkage, and shafts to see that they are in good condition, securely mounted, properly connected, and not excessively worn. Apply steering brake levers and observe whether they begin to take hold at 6 to 8 notches of travel on ratchet.</p>   |
| 75 |    | <p><b>TIGHTEN.</b> Tighten all assembly and mounting nuts and screws securely.</p>  |
| 77 | 77 | <p><b>DIFFERENTIAL.</b> Examine accessible part of the differential case in driver's compartment to see that it is in good condition, that all mounting and assembly bolts and cap screws are secure, and that there are no oil-leaks.</p>  |
| 78 | 78 | <p><b>TRANSMISSIONS.</b> Inspect transmissions to see that they are in good condition, securely mounted, and not leaking. If condition or level of lubricant indicates necessity for oil change, drain and refill to correct level with specified oil. See lubrication order, paragraph 32.</p>   |
| 78 |    | <p><b>ADJUST.</b> Adjust transmission front band (paragraph 122).</p>   |
| 79 | 79 | <p><b>TRANSFER UNIT (SEALS AND LEAKS).</b> Inspect the transfer unit to see that it is in good condition, securely assembled, and mounted. Note whether oil is leaking from the case of seals. If condition or level of lubricant indicates the necessity for oil change, drain and refill to correct level with specified oil. See lubrication order, paragraph 32.</p>  |
| 79 |    | <p><b>TIGHTEN.</b> Tighten all external assembly and mounting bolts and cap screws securely.</p>  |

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| 80 | 80 | TRANSMISSION AND TRANSFER UNIT CONTROLS AND LINKAGE. See that control levers and linkage for these units are in good condition, correctly assembled, and securely connected and mounted. See that joints are adequately lubricated and not excessively worn.   |
| 81 | 81 | PROPELLER SHAFTS (UNIVERSAL JOINTS, ALINEMENT, AND YOKES). Inspect propeller shafts for good condition, correct and secure assembly. See that universal joints are not excessively worn and inspect for adequate lubrication. Look for excessive leaks at seals of universal joints and at sliding joint.  |
| 81 |    | TIGHTEN. Tighten all universal joint assembly and yoke cap screws securely.  |
| 85 | 85 | LIGHTS AND SWITCHES (HEAD, TAIL, BLACKOUT, AND INTERNAL). If tactical situation permits, test switches and lamps (lights) to see that they operate properly. Inspect all lights for good condition, secure mounting, for broken lenses, and discolored reflectors.   |
| 86 | 86 | WIRING (JUNCTION AND TERMINAL BLOCKS AND BOXES). Inspect to see that all exposed electrical wiring and conduits, terminal blocks, and boxes are in good condition, well supported, and securely connected. Be sure radio noise capacitors and/or wiring support clip bondings are in good condition, clean, and securely mounted or connected.   |
| 88 | 88 | RADIO BONDING (SUPPRESSORS, FILTERS, CONDENSERS, AND SHIELDING). See that all units not covered in the foregoing specific procedures are in good condition and securely mounted and connected. Be sure all additional noise suppression bond straps and internal and external toothed lock washers listed in paragraph 106 are inspected for looseness or damage, and see that contact surfaces are clean. If objectionable radio noise from vehicle has been reported, make tests in accordance with paragraph 48. If cleaning and tightening of mountings and connections and replacement of defective radio noise suppression units does not eliminate the trouble, the radio operator will report the condition to the designated individual in authority. |

## ROAD TEST—Continued

### ARMAMENT

#### Howitzers: 155-mm. Howitzer (Mounts, Traversing, and Elevating Mechanism, Firing Controls)

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Inspect to see that these items are in good condition, clean, well lubricated, correctly and securely assembled, and not excessively worn. Check to see that firing controls are in good condition and secure. Operate firing controls to see that they function properly. Operate hand-elevating controls through entire range, to see that they function properly. Traverse mount by hand to see if there is any binding, and that mount can be turned through its entire range (17° left–21° right). Inspect electric elevating mechanism including motor, limit switch, wiring and operating control switch to see that they operate properly, are in good condition, correctly assembled, secure, and not excessively worn. Add oil to elevating gear case if required. Make an operating check of power-elevating mechanism moving motor switch to either UP or DOWN or MANUAL position (fig. 17) to see if gun responds properly and any over-run is properly controlled. Tighten all assembly and mounting bolts and screws securely.

### TOOLS AND EQUIPMENT

#### Tools (Vehicle Kit and Pioneer)

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|-----|-----|--|
| 130 | 130 | Check vehicle and pioneer tools to see that all items are present, in good condition, and properly stowed or mounted. Any tools mounted on outside of vehicle, having bright or polished surfaces, should be painted or otherwise treated to prevent glare or reflections. Tools with cutting edges should be sharp and edges should be protected. |
| 131 | 131 | <b>EQUIPMENT.</b> Check special equipment items against vehicle stowage lists to see if they are all present, in serviceable condition, and properly stowed or mounted.  |
| 132 | 132 | <b>SPARE TRACK BLOCKS.</b> Inspect to see if they are all present, in good condition, and properly stowed or mounted.  |

## ROAD TEST—Continued

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|-----|-----|---|
| 133 | 133 | <b>SPARE OIL SUPPLY (RECOIL, HYDRAULIC, ENGINE).</b> Check to see that supply of listed spare oil is present and properly stowed. This supply should be maintained at all times.  |
| 134 | 134 | <b>DECONTAMINATOR.</b> Examine decontaminator to see that it is in good condition, secure, and fully charged. Make latter check by removing filler plug.  |
|     |     | <i>Note.</i> The solution must be renewed every 3 months as it deteriorates.  |
| 135 | 135 | <b>FIRE EXTINGUISHER (PORTABLE).</b> Inspect extinguisher to see if it is fully charged, in good condition, securely mounted, and if seal on valve head is intact. Weigh cylinder to determine if it is fully charged.  |
| 136 | 136 | <b>PUBLICATIONS AND FORM No. 26.</b> Check to see whether vehicle manuals, Lubrication Order, Accident-Report Form No. 26 and Form No. 478, MWO and Major Unit Assembly Replacement Record are present, legible, and properly stowed.   |
| 137 | 137 | <b>VEHICLE LUBRICATION.</b> Perform a complete lubrication service on the vehicle according to instructions in lubrication order, paragraph 33, omitting only those items which have received attention in the foregoing specific procedures. Replace damaged or missing fittings, lines, or plugs.   |
| 138 | 138 | <b>MODIFICATIONS (MODIFICATION WORK ORDERS COMPLETED).</b> Inspect vehicle to determine that all Modifications Work Orders have been properly completed and entered on Form No. 478. Enter all modifications or major unit assembly replacements made at time of this service.  |
| 139 | 139 | <b>FINAL ROAD TEST.</b> Make a final road test, rechecking items 2 to 15, inclusive. Recheck transmission and differential to see that lubricant is at correct level and that there are no leaks. Confine this road test to the minimum distance necessary to make satisfactory observations. While testing vehicle, operate it in a normal manner. |

*Note.* Correct or report any deficiencies found during final road test to designated authority.

## Section XV. TROUBLE SHOOTING

### 41. General

a. This section contains trouble-shooting information and tests which can be made to help determine the causes of some of the troubles that may develop in vehicles used under average climatic conditions (above 32° F.). Each symptom of trouble given under the individual unit or system is followed by a list of possible causes of the trouble. The tests necessary to determine which one of the possible causes is responsible for the trouble are explained after each possible cause.

b. When trouble shooting, first turn to the subparagraph pertaining to the condition at hand, and then perform the various tests in the order listed. This is important because the tests which are easiest to perform and conditions most likely to occur are listed in their respective order.

### 42. Engine

a. **STARTER DOES NOT CRANK ENGINE.** (1) *Open switch in starting circuit.* In order to complete the starting circuit, the emergency ignition switch and the regular ignition switch, as well as the master battery switch, must be ON. Make sure that all of these switches are turned on.

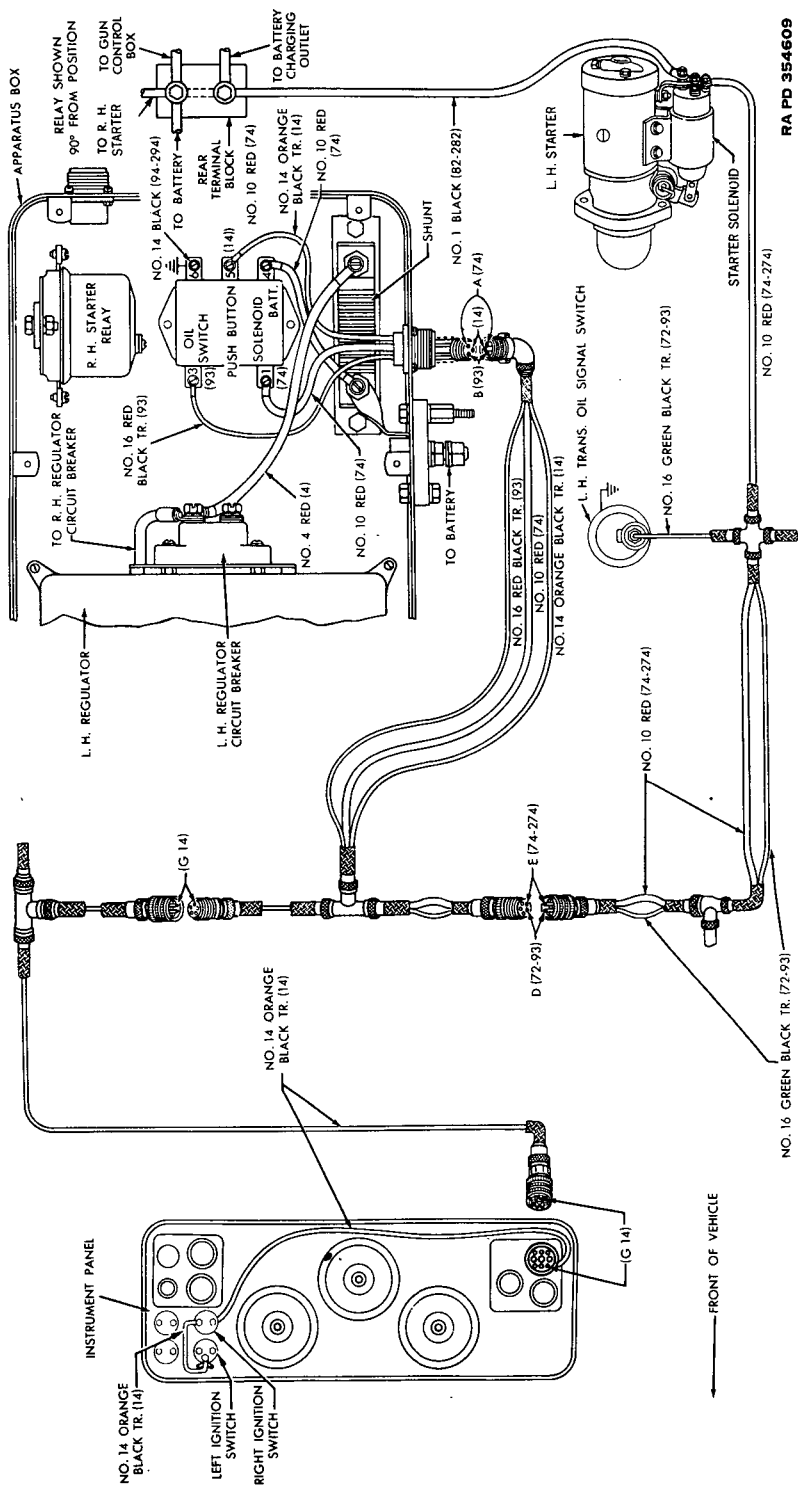
(2) *Battery ground circuit open.* Turn on lights. If lights do not light, battery ground circuit is open or master switch is inoperative. Check ground circuit and switch with test lamp or voltmeter (fig. 39).

(3) *Loose connection in starting circuit.* If lights go on properly, press starter button; then if lights go out, there is a poor connection at the terminals, at the batteries, at the ground strap, at the master switch, or at the starter (fig. 37). These can be checked by a voltmeter between each successive terminal and ground. Clean and tighten loose connections, replace broken ground straps, or replace defective master switch.

**Note.** All wires in the vehicle are marked at all connecting ends with the circuit number, and these circuit numbers appear in all of the wiring diagrams in this section.

(4) *Battery run down.* If lights dim considerably when starter button is pressed, but still burn, batteries are low. Test batteries with a hydrometer and a high-rate discharge tester, if available. Replace any battery units that do not test satisfactorily.

(5) *No ground in starter relay circuit.* When the starter button is first pressed, the starter relay circuit is grounded through the transmission oil pressure warning signal switch (fig. 37). If lights do not dim at all, and transmission warning light on the instrument panel does not light, the signal switch is probably defective. A test can



**Figure 37. Starting circuit.**

readily be made by grounding signal switch lead wire and this will permit starting the engine.

(6) *Open starter circuit.* If lights do not dim at all when starter button is pressed, no current is flowing to the starter. If cause is not in ground circuit, use test lamp to determine if feed circuit is complete to relay terminal; then to solenoid coil, and finally to starter terminal (fig. 37). Replace relay lead, relay, solenoid, or cable as required.

(7) *Starter inoperative.* If previous tests indicate current to starter terminal and starter does not turn, replace starter.

**b. ENGINE CRANKS BUT WILL NOT START.** (1) *Slow cranking speed.* Check for wrong grade of engine oil. Check battery state of charge, connections, and ground strap (subpar. *a* above). Check for tight bearings or tight pistons and rings. Replace starter.

(2) *Fuel lines shut off.* Turn on fuel switch.

(3) *Fuel supply exhausted.* Replenish fuel supply.

(4) *Carburetor flooded.* A flooded condition may occur after repeated cranking. Usually one engine starts and the other does not. If flooded condition is suspected, hold accelerator wide open while starting engines.

(5) *Inoperative ignition system.* Open engine compartment, remove ignition wire from one spark plug and hold terminal one-fourth inch from cylinder head. Turn on ignition and crank engine. If strong, blue-white spark jumps gap, ignition is satisfactory. If no spark appears or spark is weak or red, proceed with tests in paragraph 43.

(6) *Carburetor operating improperly (par. 50).*

**c. ENGINE STOPS.** (1) *Break in ignition system.* Check ignition wires and connections for looseness or breaks. Check breaker points to see that they are not stuck in the open position or not opening due to incorrect gap adjustment. Tighten, repair, or replace as necessary.

(2) *Inoperative fuel system.* Check all fuel lines and connections for breaks and clogging, and reconnect, clean, or repair as required (par. 50). Clean gasoline filters and screens.

**d. ENGINE OPERATES UNEVENLY.** (1) *Ignition system operating improperly.* Check for inadequate ignition (par. 43).

(2) *Carburetor operating improperly.* Check carburetor adjustment and condition (par. 50).

(3) *Engines not synchronized.* Check tachometers for differences in engine speed and tune engines, or readjust throttle linkage as required (par. 110).

(4) *Leaking intake manifold or cylinder head gaskets.* Listen for air leaks and test for leaks by applying engine oil (OE 10) to suspected areas. Tighten or replace affected gaskets.

(5) *Valves sticking, warped, or burned.* Check compression pressure. The compression pressure at cranking speed should be 102

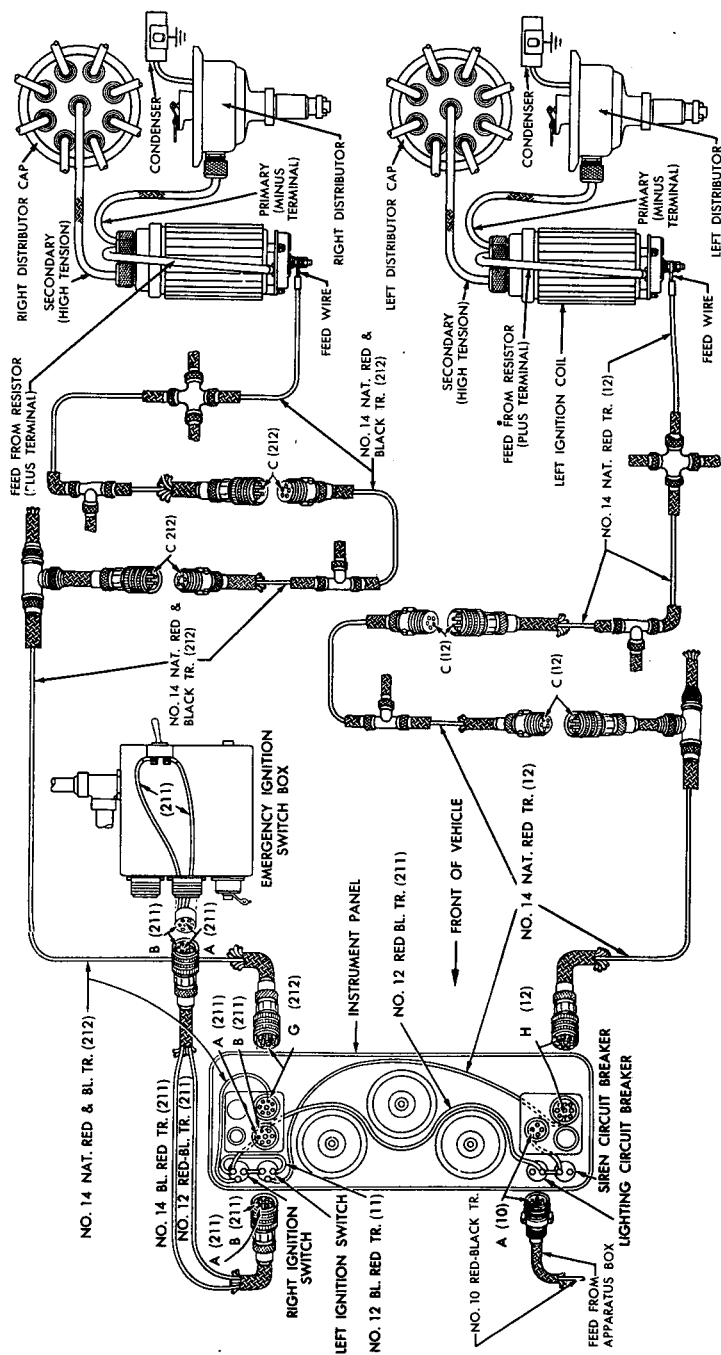


Figure 38. Ignition circuit.



pounds or more. If the compression pressure at cranking speed falls below 95 pounds, notify higher authority.

(6) *Pistons, rings, or cylinders worn.* Check compression pressure. If pressures vary considerably, or if all cylinders are low, notify higher authority.

e. **ENGINE OVERHEATS.** (1) *Low level of coolant.* Check level of coolant and fill to correct level with water or antifreeze. Also check system thoroughly to determine cause of coolant loss (par. 49).

(2) *Belts loose or broken.* The belts drive the generator, water pump, and fan. Inspect belts and, if necessary, adjust to obtain  $\frac{5}{8}$ -to  $\frac{3}{4}$ -inch slack measured as shown in figure 47.

*Note.* Belts are matched in sets. If one belt is broken, all three belts must be replaced at the same time.

(3) *Radiator air inlet plugged.* Open ventilating sliding doors on bulkhead (fig. 13). Check radiator core air passages to see if plugged with dirt, leaves, or twigs. Clean out. See that inlet and outlet grilles on top of vehicle are not covered with tarpaulin or other equipment. Remove screen from inlet grille and clean.

(4) *Mechanical failure in cooling system.* Check thoroughly as outlined in paragraph 49.

(5) *Ignition timing late.* Check and reset ignition timing (par. 73).

(6) *Engine oil level low.* Check oil supply and add to the correct level.

(7) *Radiator thermostat sticking.* Replace thermostat (par. 117).

f. **ENGINE OPERATES NOISILY.** (1) *Light knock or ping on acceleration.* Check grade of gasoline used; it should be 80 octane. Check or reset ignition timing (par. 73). Remove cylinder heads and clean carbon (par. 60).

(2) *Clicking noises synchronized with camshaft speed.* Check oil level; an overfilled crankcase will cause oil to foam and valve lifters to become noisy. Drain oil to correct level. Check conditions of crankcase oil and change oil if dirty or gritty.

(3) *High-pitched squeals.* Inspect fan, generator, distributor, and water pump for underlubricated or frozen bearings. Lubricate or replace unit, as required.

(4) *Heavy knocks synchronized with crankshaft speed.* Crankshaft or connecting rod bearings burned out. Notify ordnance personnel.

g. **ENGINE OIL PRESSURE LOW (WARNING LIGHT STAYS ON).** (1) *Low oil level.* Check oil supply and add oil to the full mark on gage.

(2) *High oil level.* If oil level is high (above the full mark), it may be an indication that the fuel pump switch has been left on while the engine has not been running and raw gasoline has passed through the carburetor and manifolds and into the crankcase, causing oil dilution

and low oil pressure. Drain crankcase and install fresh oil (par. 33). Overfilling of crankcase should be avoided at all times.

(3) *Oil worn out or incorrect grade.* Check log book entries for mileage of last oil change and grade of oil used. Refill with correct grade of engine oil.

(4) *Broken line to valve lifters.* Inspect oil feed line from side of cylinder block to valve lifter connection at center of vee, and replace if cracked or broken. Replenish oil.

(5) *Oil pressure warning signal switch defective.* If no cause of low oil pressure can be found, the trouble may be in the oil pressure warning signal switch at the rear of the engine. Replace switch (par. 97).

(6) *Worn oil pump gears.* Remove oil filter inlet pipe at front of cylinder block and install pressure gage. If pressure is below 12 pounds with engine idling, notify ordnance personnel.

### 43. Ignition System

a. NO SPARK IN ONE CYLINDER. (1) *Spark plug wiring faulty.* Make visual inspection of wiring to determine if disconnected, broken, or shorted. Reconnect, repair, or replace as required. Check current to plug by cranking engine with wire disconnected and terminal at end of ceramic insulator held one-fourth inch from cylinder head. If no spark jumps, wiring is shorted or broken and must be replaced.

(2) *Spark plug faulty.* If strong spark jumps with above test, fault is in plug. Remove plug and inspect for cracked insulator, broken electrodes, fouling, or incorrect gap. Clean, readjust, or replace as required.

b. NO SPARK TO ANY CYLINDER. (1) *Distributor cap faulty.* Inspect distributor cap for loose mounting, moisture, dirt, or cracked or burned condition, and dry off, clean, or replace as necessary.

(2) *Wiring defective.* Inspect high-tension wire and low-tension wire from distributor to coil, and back through feed circuit (fig. 38).

(3) *Contact points inoperative.* Remove distributor cap and inspect contact points for gap, burned condition, and spring tension. Service or replace in accordance with instructions (par. 70).

(4) *Defective coil or condenser.* Check coil and condenser with instruments or by substitution, and replace one or both units as required.

### 44. Battery Circuit

a. NO CURRENT IN BATTERY CIRCUIT. (1) *Master switch open.* Close master battery switch.

(2) *Loose cable connections.* Inspect all cable connections at battery, apparatus box, and terminal blocks (fig. 39) and clean and tighten if necessary.

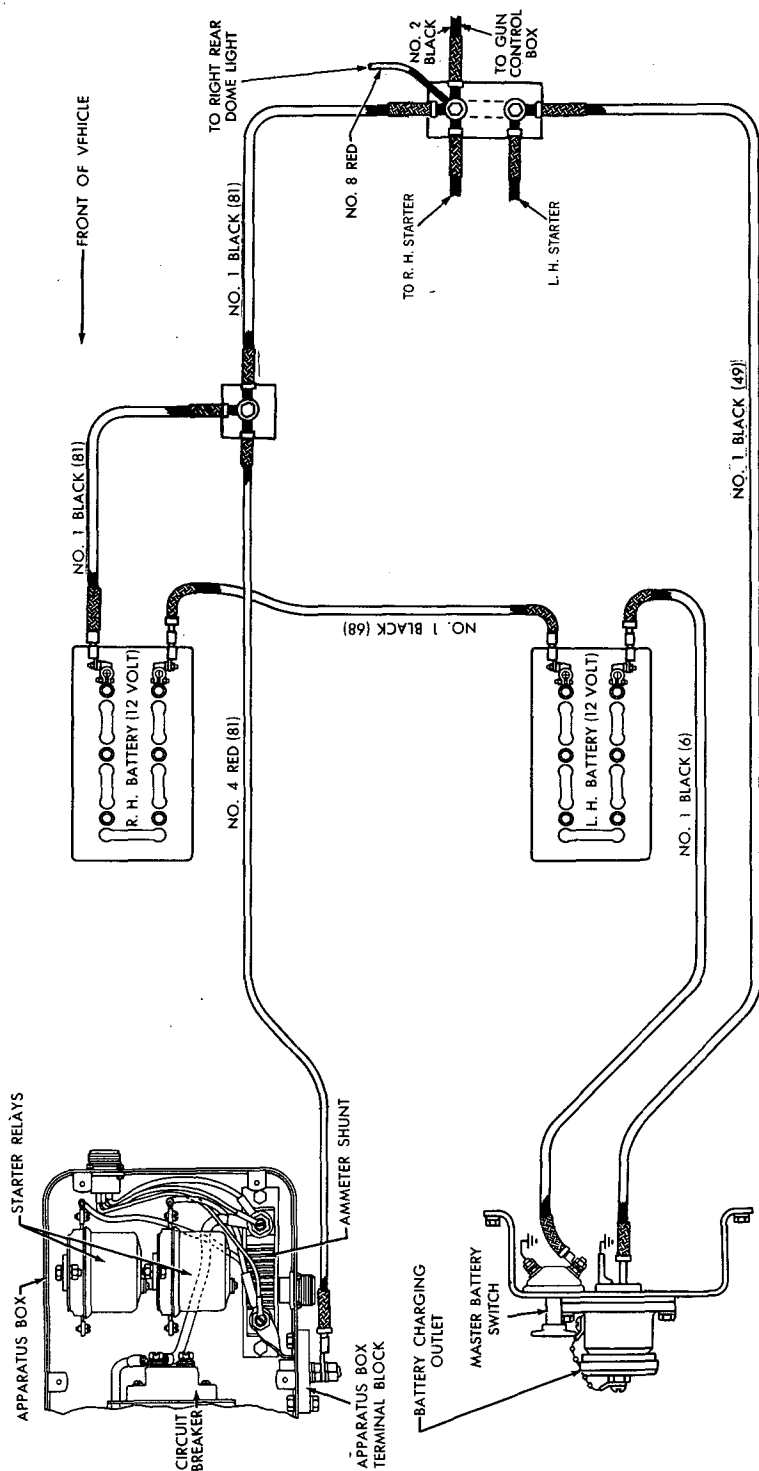


Figure 39 Battery circuit.

(3) *Battery ground circuit open.* Turn on lights. Connect a heavy jumper wire between negative terminal of left battery and ground (fig. 39). If lights burn, ground circuit is open or master switch is defective. Check ground circuit and switches with test lamp. Clean and tighten terminals on ground end of cables.

(4) *Battery to shunt circuit open.* If lights do not burn, run a heavy jumper wire from positive terminal of left- or right-hand battery to lower terminal of shunt in apparatus box (fig. 39). If lights burn, circuit is open on both left- and right-hand batteries. Check with test lamp or jumper from terminal to terminal and correct condition on both left- and right-hand circuits.

(5) *Battery connecting cable loose or broken.* If lights still do not burn, test cables that connect batteries, using a jumper. Replace cable if broken or defective.

(6) *Battery discharged—one or more cells dead.* Check each cell of each battery with hydrometer and voltmeter. If battery is low, recharge with outside source or engine generators, or replace, as tactical situation permits. If one or more cells are dead, replace units containing defective cells.

b. **BATTERIES DO NOT STAY CHARGED.** (1) *Excessive use of electrical equipment.* Keep one or both engines running at 1,500 revolutions per minute while using electrical equipment in accordance with the load.

(2) *Generator charging rate inadequate.* Check and service charging circuit (par. 46).

(3) *Batteries not capable of holding a charge.* Test each battery with hydrometer and high discharge test. Replace substandard battery units. Check for batteries connected with reversed polarity.

## 45. Lighting System

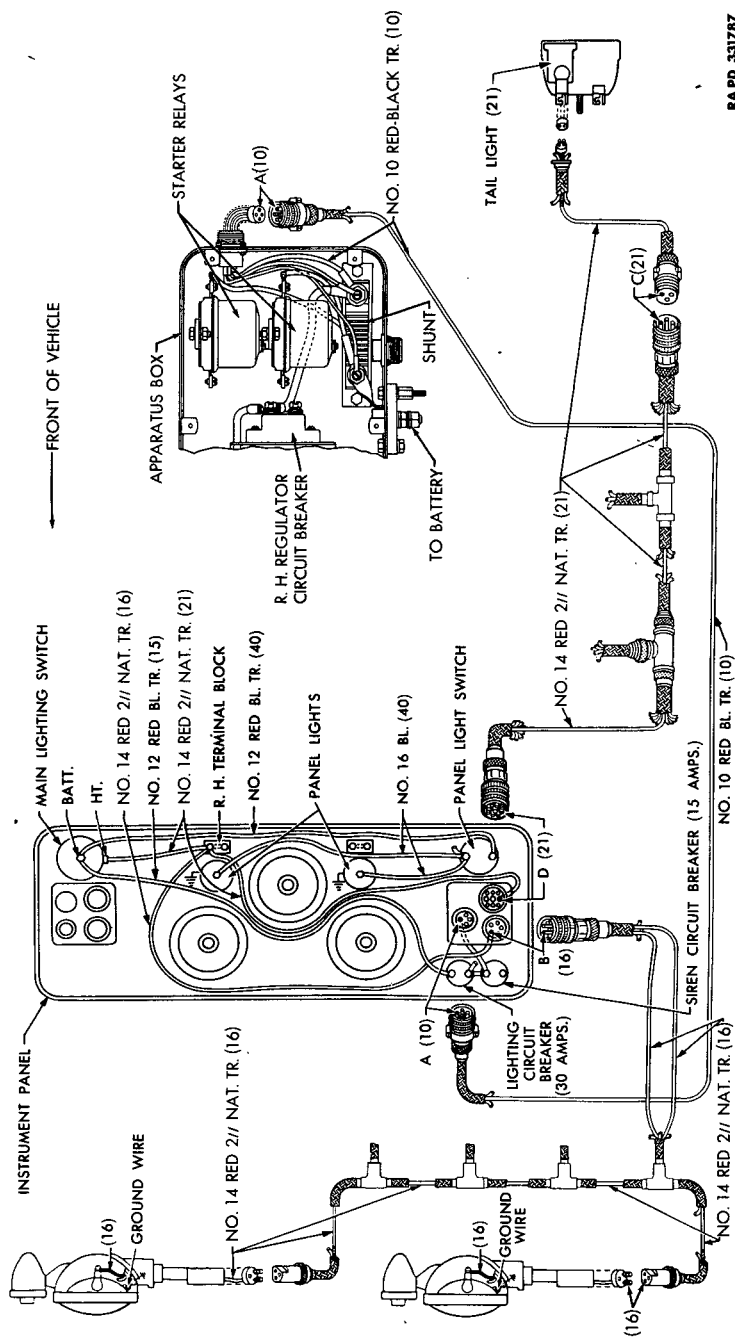
a. **NO LIGHTS.** (1) *Circuit breaker open.* Reset lighting system circuit breaker by pressing button on instrument panel (fig. 6).

**Caution:** If circuit breaker will not stay closed, do not hold in closed position. Check lighting circuit for short or ground.

(2) *No current in feed circuit.* Use test lamp or voltmeter to check power feed to lighting switch BATTERY terminal. If there is no current to this point, check back through the feed circuit (figs 40, 41 or 42) until the "short" or "open" is located, and repair or replace wiring or conduit as required.

(3) *Defective lighting switch.* If power feed-to-switch is satisfactory, use a jumper wire to connect BATTERY terminal with other terminals. If lights burn, replace lighting switch.

b. **ALL LIGHTS DIM.** (1) *Battery voltage low.* Check battery condition with hydrometer and voltmeter. Recharge or replace batteries as required.



*Figure 40. Service light circuit.*

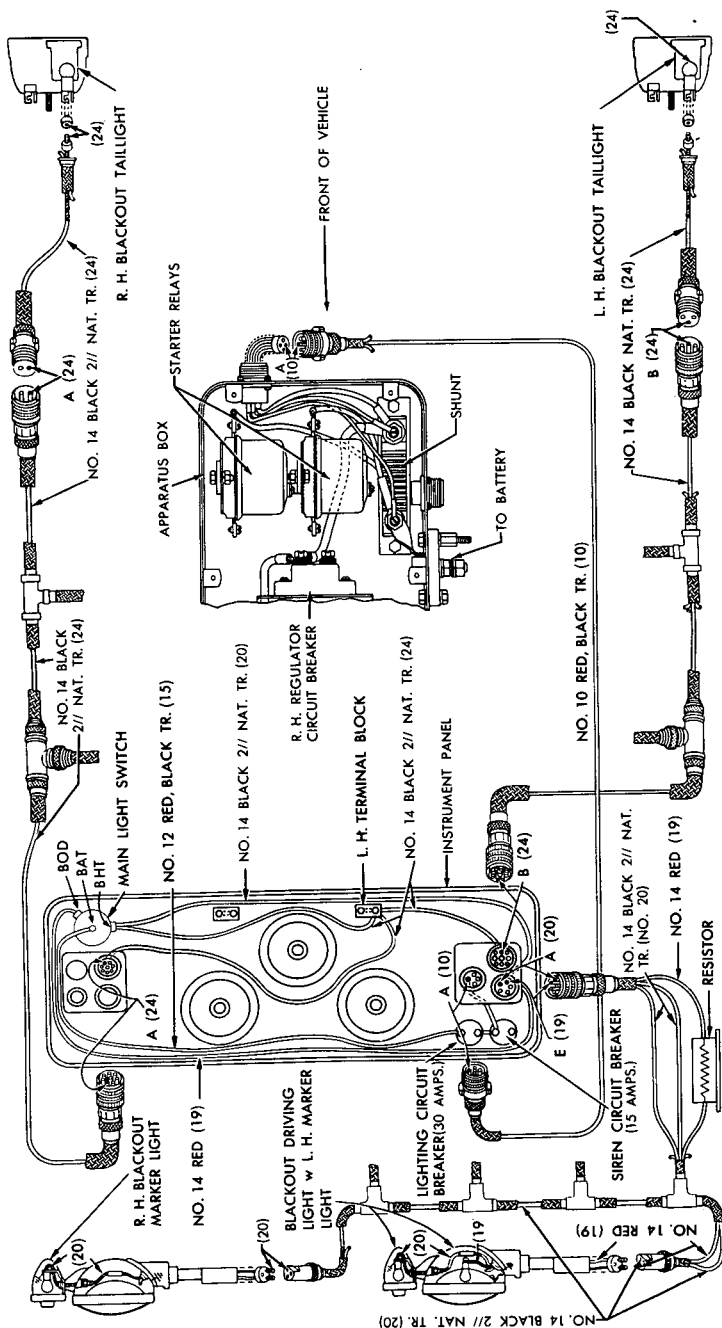


Figure 41. Blackout light circuit.

(2) *High resistance in feed circuit.* Check back through lighting switch feed circuit with voltmeter to locate and correct high-resistance condition.

(3) *High resistance in lighting switch.* If circuit checks satisfactorily and all connections are tight, replace lighting switch.

c. ONE HEADLIGHT, TAILLIGHT, OR MARKER LIGHT DOES NOT LIGHT.

(1) *Burned-out lamp.* Check lamp unit by replacing with one known to be good.

(2) *Dirt on lamp contact.* Clean any foreign matter from lamp contact.

(3) *Open circuit to light.* If replacement of lamp does not correct the condition, check back through circuit to lighting switch, using test lamp or jumper wire, and correct "open" or "shorted" condition as required.

(4) *Defective lighting switch.* If circuit checks back to lighting switch, connect a jumper between BATTERY terminal on switch and affected terminal. If light burns, replace lighting switch.

*Note.* The foregoing procedure also applies to the instrument panel lights and to the dome lights, except that the circuits must be traced back through their respective switches and feeds (figs. 40 and 47).

d. STOP LIGHTS DO NOT OPERATE. (1) *Burned-out lamp.* If only one stop light fails to operate, check for burned-out lamp by replacement.

(2) *Open circuit to one light.* If only one light fails to operate and replacement of the lamp does not correct the condition, check back through the circuit with jumper or test lamp until "open" or "short" is discovered and corrected.

(3) *Defective stop light switch.* If neither service nor blackout stop lights burn, check each of the stop light switches in turn by connecting the terminals with a jumper wire. Replace defective switch.

(4) *Open circuit to stop light switches.* If neither stop light switch proves defective, check circuit from main lighting switch through stop light switches and back, and correct any breaks or loose connections.

(5) *Defective main lighting switch.* If circuit through stop light switches checks correctly, other lights will burn properly, but none of the stop lights will operate. Replace main lighting switch.

## 46. Charging System

a. GENERATOR CHARGES LITTLE OR NOT AT ALL. (1) *Belts excessively loose.* Adjust drive belts to obtain  $\frac{5}{8}$ - to  $\frac{3}{4}$ -inch slack (fig. 50).

*Note.* Generator tests should be made on one generator at a time.

(2) *Battery fully charged.* Test Battery with hydrometer. If fully charged, regulator will prevent appreciably generator output.

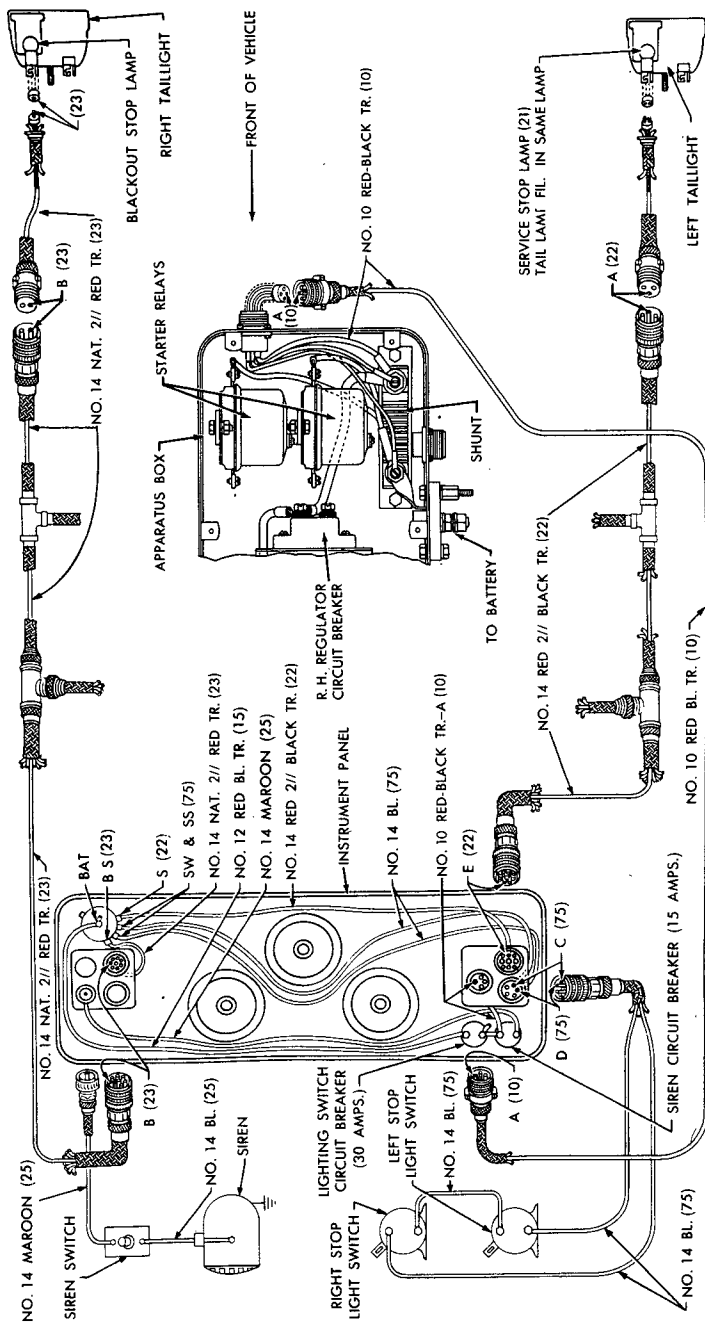


Figure 42. Stop light and siren circuits.



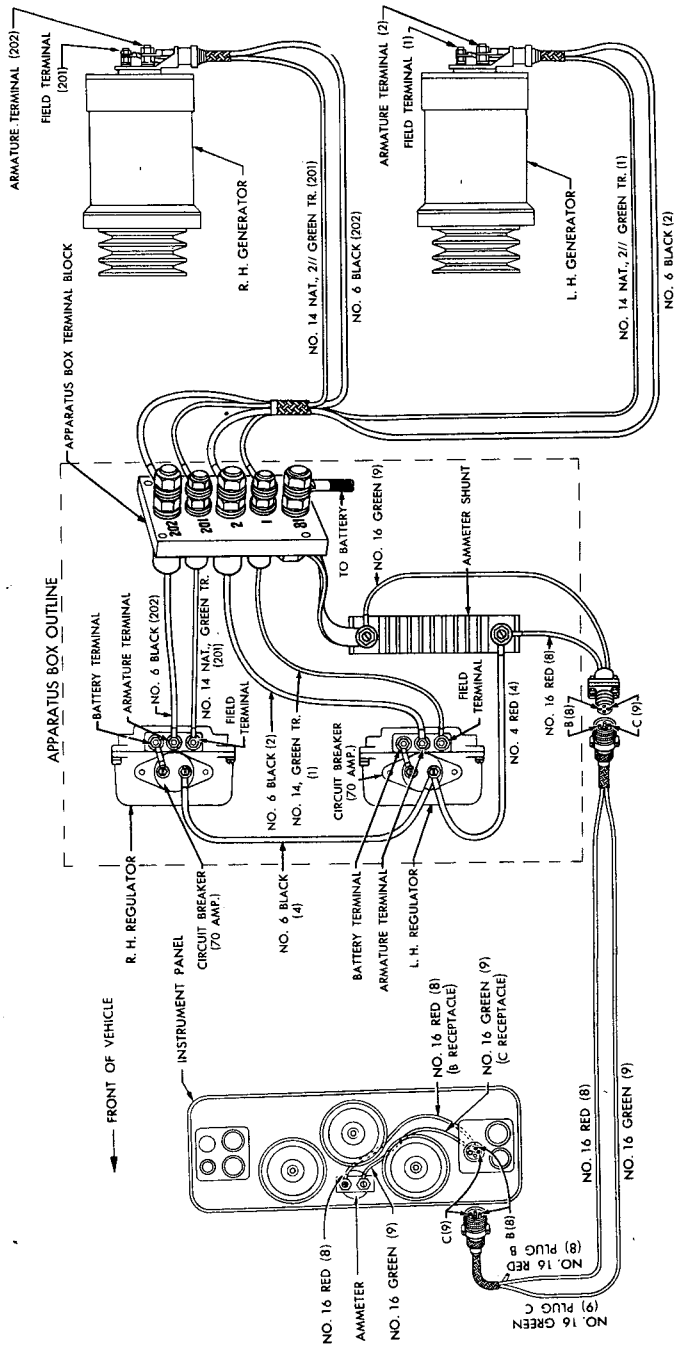


Figure 43. Charging circuit.

(3) *Defective ammeter.* Connect precision ammeter in circuit. Replace vehicle ammeter if defective.

(4) *High resistance in charging circuit.* Check entire charging circuit (fig. 43) for loose or corroded connections using voltmeter, and correct any conditions causing high resistance. High resistance makes regulator operate as if battery were fully charged.

(5) *Inoperative regulator.* Check regulator action by substituting a regulator known to be satisfactory. If charging circuit is satisfactory, replace defective regulator.

(6) *Inoperative generator.* If replacement of regulator does not remedy condition, replace generator.

## **47. Electrical Instruments and Equipment**

*a. TEMPERATURE GAGE DOES NOT REGISTER.* (1) *Open feed circuit.* Connect jumper wire from gage unit in instrument panel back to ignition switch (fig. 45). If gage operates, replace feed wire.

(2) *Defective gage unit.* If gage does not operate when jumper wire is connected, gage unit is defective. Replace gage unit.

*b. TEMPERATURE GAGE READS HIGH AT ALL TIMES.* (1) *Defective engine unit.* Disconnect lead at engine unit. If gage drops to low side, engine unit is defective. Replace engine unit.

(2) *Circuit to engine unit grounded.* If gage remains high with wire disconnected, use test lamp to determine place where line between engine unit and gage unit (fig. 45) is grounded.

(3) *Defective gage unit.* If no ground is found in circuit, replace gage unit on instrument panel.

*c. TEMPERATURE GAGE READS LOW AT ALL TIMES.* (1) *Circuit to engine unit open.* Connect test light to engine unit terminal and to ground. If light does not burn, check back through circuit for loose or broken connection.

(2) *Defective engine unit.* If lamp lights, disconnect lead at engine unit and watch gage unit. If gage unit has high reading, engine unit is defective. Replace engine unit.

(3) *Defective gage unit.* If gage unit does not show high reading under the above circumstances, it is defective. Replace gage unit.

*d. WARNING SIGNALS DO NOT LIGHT WHEN IGNITION IS TURNED ON.*

(1) *Burned-out lamp.* If only one signal fails to light, the fault is probably in the lamp on the instrument panel. Check by replacing with new lamp (par. 93).

(2) *Defective engine or transmission unit.* If only one signal fails to light, and the lamp is not at fault, disconnect wire to affected switch on engine or transmission and ground it. If lamp lights, replace switch.

(3) *Open circuit.* If lamp fails to light, use test lamp to check

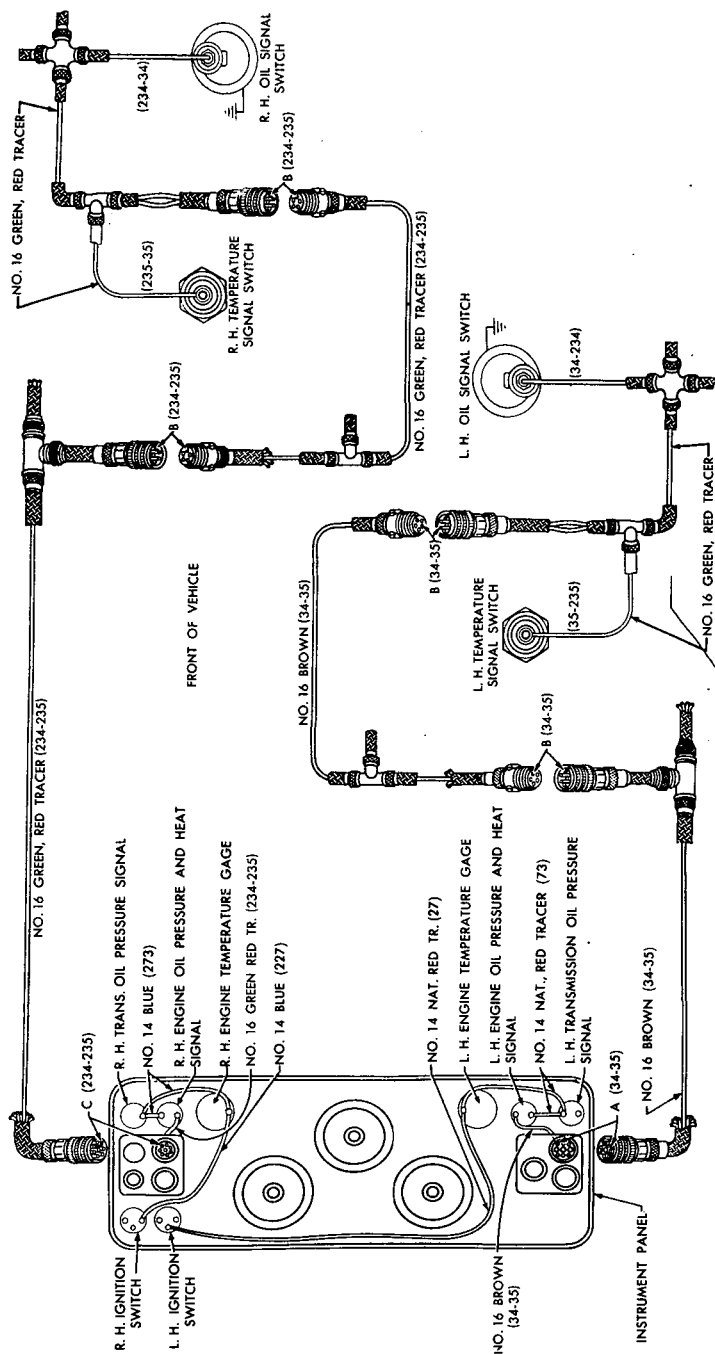


Figure 44. Engine oil pressure and heat signal circuit.

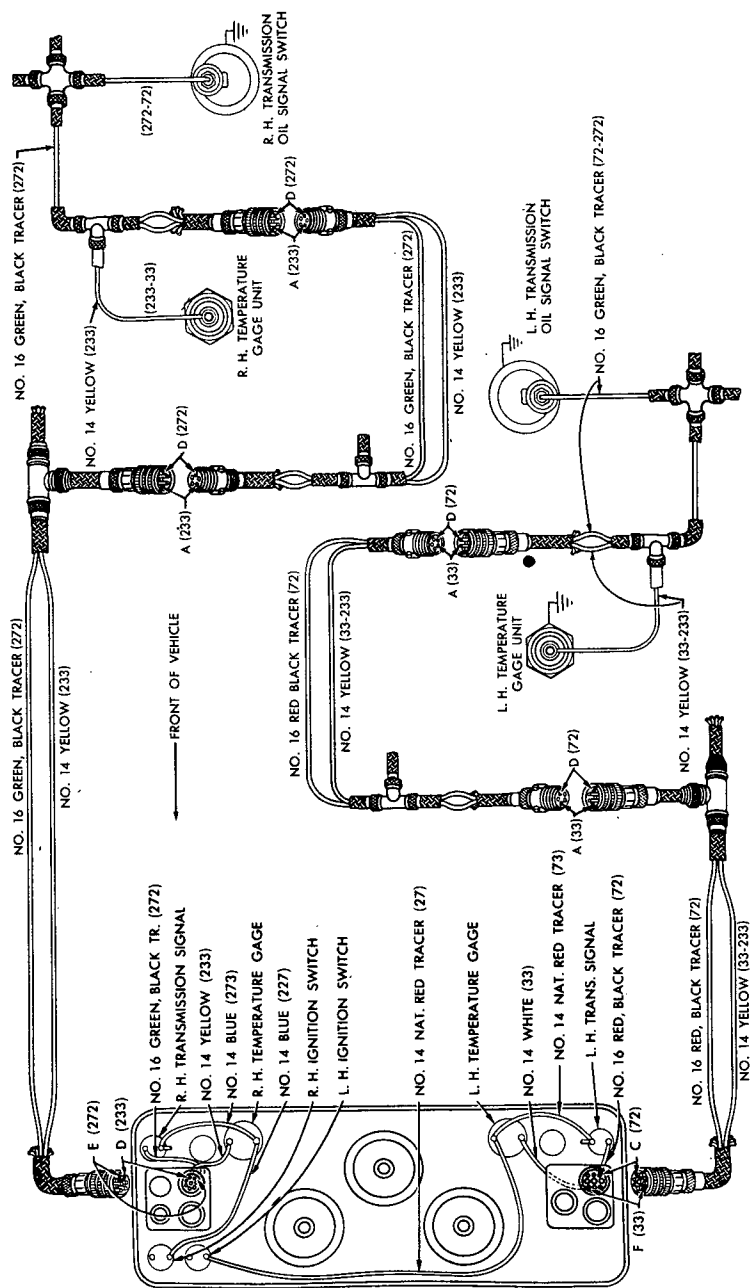


Figure 45. Engine temperature gage and transmission signal circuit.

back through affected circuit (fig. 44 or 45), and correct condition causing open circuit.

**e. WARNING SIGNALS LIGHT.** (1) *Low oil pressure or high temperature.* Ordinarily, lighted signals means high engine temperature, or low oil pressure in engine or transmission. If, however, a check of gages and oil levels indicates nothing abnormal, check the electrical warning circuit as follows:

(2) *Defective engine or transmission switch.* Disconnect lead at switch. If light goes out, replace switch.

(3) *Ground in circuit.* Check back through affected circuit (fig. 44 or 45), using test lamp or voltmeter to locate and correct grounded condition.

**f. SIREN FAILS TO OPERATE.** (1) *Circuit breaker open.* Push reset button on instrument panel.

(2) *Siren switch defective.* Test switch with jumper wire. If siren operates, replace switch.

(3) *Open circuit to siren.* Check back through siren circuit (fig. 42) with test lamp or voltmeter. Locate and correct "open" or "short" condition.

(4) *Defective siren.* If circuit checks satisfactorily, siren is defective. Replace siren (par. 98).

**g. SIREN OPERATES WEAKLY.** (1) *Battery voltage low.* Check with voltmeter. Recharge or replace affected battery units.

(2) *High resistance in siren circuit.* Check back through siren circuit (fig. 42) with voltmeter. Locate and correct high resistance condition.

(3) *Defective siren.* If circuit checks satisfactorily, siren is defective. Replace the siren.

**h. FUEL PUMPS (ONE OR BOTH) FAIL TO OPERATE.** (1) *Circuit breaker open.* Push circuit breaker reset button on fuel switch bracket.

*Note.* Open circuit breaker would make both pumps inoperative.

(2) *Defective switch.* Test fuel-pump switch, using jumper wire. If pump operates with jumper in place, replace switch.

(3) *Open circuit to pump.* Check entire pump-feed circuit (fig. 46) from ignition switches to connection at pump support. Locate and correct cause of open circuit.

(4) *Defective lead in fuel tank.* If circuit checks to terminal on pump support, remove support assembly from fuel tank (par. 111) and check lead to pump. Replace if defective. One ignition switch must be on when testing pump circuit.

(5) *Defective pump.* If lead to pump checks satisfactorily, pump is defective. Replace the pump (par. 111).

**i. VENTILATOR FAILS TO OPERATE.** (1) *Circuit breaker open.* Push circuit breaker reset button on left front of ventilator assembly.

(2) *Open feed circuit.* Check feed circuit with test lamp at connector. If there is no current, check back through circuit (fig. 47) until open circuit is located and corrected.

(3) *Defective ventilator.* If feed circuit checks, ventilator has internal short, broken switch, or other defect. Replace complete ventilator assembly (par. 103).

## **48. Radio Interference Suppression**

*a. PRELIMINARY INSTRUCTIONS.* When checking radio interference, test the vehicle in a location free from high-tension lines, other vehicles, machinery, and electrical equipment which could be a source of interference. Stop engine and turn off all vehicle electrical equipment. Turn on radio and check noise level. Listen carefully to type of noise present under these conditions. This registering of noise sounds is done so that when vehicle equipment is checked, the presence of a new noise or interference can be immediately detected. Checking noise level is also done so that noises already present will not be attributed to lack of vehicle suppression. If noise level with all vehicle equipment shut off is too high, due to atmospheric conditions or other outside causes, delay further checking if tactical situation permits until such time as moderate noise levels prevail. Disconnect the radio terminal box capacitor (terminal end) (fig. 87). If radio interference does not increase, replace capacitor. If interference increases, as it should, leave terminal box capacitor disconnected for the remainder of the tests, or until any defective equipment has been located, replaced, and tested. Examine all shielded conduits and cables to make sure couplings are tight and conduits and cables are clamped or bonded to hull at least every 2 feet.

*b. NOISE CAUSED BY IGNITION SYSTEM OF VEHICLE ENGINES.* Radio noise caused by the engines of the vehicle can be determined by running first one engine and then the other engine. It is very unlikely that noise will be present in both engines at the same time. However, if such is the case, the remedies given below will apply for both engines.

(1) *Loose or damaged conduits or wiring.* Examine conduit of ignition system and see that all coupling nuts and terminal connections are tight and that conduit is not broken or crushed (fig. 89). Replace any damaged conduit or wires.

(2) *Loose bonding clips or engine grounding strap.* Tighten all bonding (holding) clips and tighten engine ground strap (fig. 88).

*Note.* If remedies given in this subparagraph do not correct the trouble, and the trouble is believed due to ignition faults, refer to higher authority.

*a. NOISE CAUSED BY GENERATOR.* (1) *Faulty generator regulator.* If radio operator reports the radio interference as a clicking sound, the trouble is probably due to a faulty generator regulator. Tighten bolts holding regulator unit to mounting strap, tighten bonding strap be-

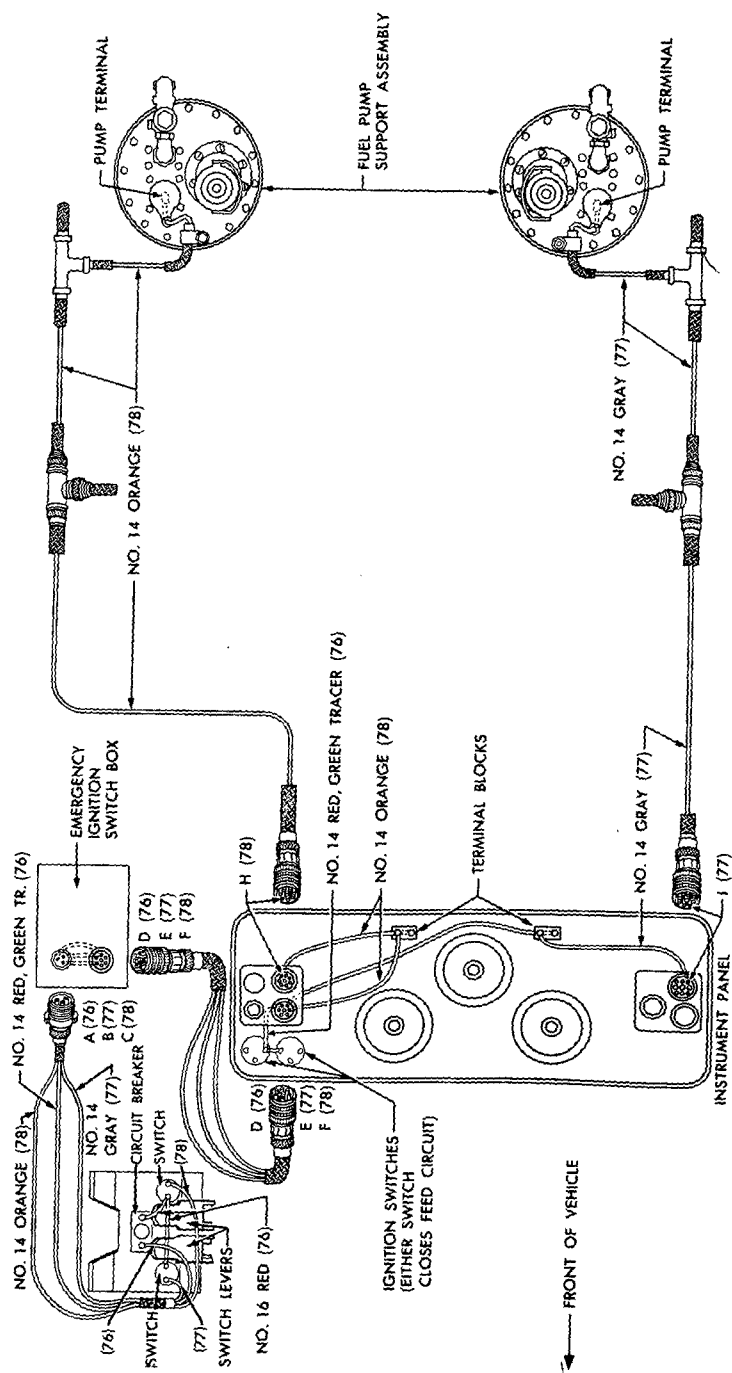


Figure 46. Fuel pump feed circuit.





tween regulator mounting strap and apparatus box (fig. 90). If noise continues, replace regulator (par. 82).

*Note.* If remedies given in this subparagraph do not correct the trouble, refer to higher authority.

(2) *Generator system noise.* If radio interference is caused by the generator system, tighten all bonding clips, coupling nuts, and ground straps (fig. 88). Examine conduit and if it is crushed or cut, or in any way damaged, replace the conduit and/or wires (par. 106). Tighten conduit fittings in junction and apparatus boxes. If noise continues, replace first one, and if necessary both, of the condensers which are found on the brush-holding plate of the generator. Replace them in the same position as the original ones were installed. If noise still continues, refer to higher authority.

*d. NOISY GUN MOUNT ELEVATING ELECTRICAL SYSTEM.* If radio noise is believed due to faults within the howitzer-mount elevating electrical system, it can be determined by elevating weapon with vehicle engines stopped. If radio interference is caused when weapon is elevated, the fault lies within the following:

(1) *Faulty conduits, wiring, or bonding.* Tighten all coupling nuts and bonding clips. Replace all defective conduit and/or wiring. If either strap or cable is damaged, refer to higher authority. Tighten all conduit fittings in junction and control boxes and tighten switches and junction blocks in switch boxes. If noise continues and trouble is not remedied, refer to step (2) below.

(2) *Faulty motor.* If cause of radio interference is not traceable to (1) above, it is probably due to a faulty motor. In either case, refer to higher authority.

*e. NOISE CAUSED BY MISCELLANEOUS SYSTEMS.* Noise may be caused by loose or damaged conduits or wires of the lighting systems, various instruments including their respective sending units such as fuel tank gages, engine temperature gage and signals, oil-pressure gage and signals, and speedometer and tachometer. Various instruments on the instrument panel and in control boxes may become loose. Battery terminals and ground cable of the batteries may work loose or become corroded or otherwise damaged. The lights of the vehicle and their switches, as well as the capacitors in windshield wipers, are also sources of radio noise.

*f. LOCATION AND REMEDY OF MISCELLANEOUS RADIO NOISE.* The same general rule for maintenance of various systems, instruments, and devices must be followed as given previously concerning correction of radio interference. A process of elimination can be applied to location of trouble within any system.

*g. RADIO INTERFERENCE NOT TRACEABLE TO ANY ELECTRICAL SYSTEM.* If radio interference persists in spite of remedies set forth in *b* to and including *f* above, the trouble is probably due to defective radio

apparatus or to faults within the structure of the vehicle. Refer to higher authority.

## 49. Cooling System

**a. LOSS OF COOLANT.** Inspect all hose connections for leaks and tighten where leaks are evident. If tightening does not stop leakage, replace hoses. Inspect thermostat housing and radiator outlet elbow for leakage at gasket and replace gasket if required. Look for leakage at radiator cap gasket when engines are at maximum operating temperature and replace complete cap if leakage occurs under pressure. Look for leaks at transmission-to-engine water pipes. Tighten connections or replace pipes and fittings as required. Inspect water pump for leaky packings, and notify higher authority if this condition is found. Look carefully for leaks at radiator core and tanks, and repair or replace radiator as required. Check for leakage at cylinder heads and blocks. Tighten head screws to 65 to 70 foot-pounds or replace gasket as required to correct leakage. If head or block is cracked, replace entire engine.

**b. ENGINE OVERHEATS.** See paragraph 42e.

**c. NO WATER CIRCULATION.** Inspect the cooling system water level and refill to bring coolant up to proper level. After refilling, check complete system to determine cause for loss of coolant. Inspect the drive belts and adjust to obtain  $\frac{5}{8}$ - to  $\frac{3}{4}$ -inch slack measured midway between water pump and generator pulley (fig. 50). Replace badly worn or damaged belts. **Caution:** Belts must be replaced in matched sets of three except in an emergency. If the latter is the case, the belts should be removed and replaced with a set of matched belts as soon as the conditions permit. If, after checking the above conditions, there is still no circulation, remove the thermostate housing and check the thermostat. If thermostat is correct, clean cooling system thoroughly (par. 115) to restore circulation. If coolant does not circulate after system has been cleaned, remove water pump and inspect for sheared impeller. If impeller is sheared, notify higher authority.

## 50. Fuel System

**a. LACK OF FUEL AT CARBURETOR.** Check position of fuel pump switches and turn to "ON" position. Make certain that fuel tank is not empty and replenish fuel supply if necessary. Check condition of carburetor strainer screen at carburetor and also check auxiliary fuel filter at carburetor inlet fitting. Clean if necessary. Inspect fuel lines for clogged or leaky condition and clean or replace as necessary. Remove fuel pump support and clean strainer screen, and screen on pump and reinstall (par. 111). Check fuel pump to find out if pump motor operates by listening for pump motor with fuel switch turned on and vehicle engine not running. If inoperative,

replace pump or notify higher authority. Inspect fuel valve, and check valve at tank and free up or replace if inoperative. Check fuel valve cable to make certain cable is not broken, disconnected, or loose and out of adjustment. Reconnect, readjust, or replace as necessary.

**b. CARBURETOR NOT OPERATING PROPERLY.** Check choke thermostat housing adjustment and reset to indicator mark, if necessary (fig. 93). Check to be sure choke is free from all sticking or binding. If choke cannot be freed by moving lever on end of shaft (fig. 94), notify higher authority. Check carburetor adjustments (par. 110) to make sure fault is not in the adjustments. If above measures do not correct the difficulties, replace carburetor or notify higher authority.

## **51. Transmission**

**a. LUBRICANT LEAKS.** Check transmission for oil leaks at the drain plug, oil pan, and side cover. Tighten drain plug or cover attaching screws to stop leak. If leak will not stop, replace gaskets or drain plug. If fluid coupling is found to be leaking, do not attempt to repair. Notify higher authority.

**b. TRANSMISSION FAILS TO TRANSMIT POWER.** Check transmission oil level and fill to level mark on gage (par. 33). If oil level was low, check transmission thoroughly for oil leaks. If transmission still does not function, adjust manual control linkage (par. 121). As a final step, check the front band adjustment (par. 122) and readjust as required.

*Note.* Rear band has automatic adjustment and does not require attention.

**c. TRANSMISSION SHIFT SPEEDS ABNORMAL.** If all shifts occur at excessively high engine speeds, check vacuum line between transmission and intake manifold for leaks at fittings or cracks in line. Repair or replace as necessary. If engine speeds up in first and third while being driven forward, the front band is out of adjustment. Readjust front band (par. 122). If engine speeds up in first and second, rear band is out of adjustment. Rear band adjustment is automatic; if band is slipping, notify higher authority. When all shifts above second occur at excessive engine speeds, the manual control linkage is improperly adjusted. Readjust manual control linkage (par. 121).

**d. VEHICLE CREEPS.** Check engines to make sure idling speed is down to 450 revolutions per minute and that throttle linkage does not bind. Eliminate bind in throttle linkage and replace missing or weak throttle return springs.

## **52. Propeller Shafts**

**a. VIBRATION AT UNIVERSAL JOINTS.** Replace all propeller shaft joints having worn needle bearings. Check shafts for run-out and replace all affected shafts.

**b. HEAVY THUMPS ON ROUGH TERRAIN.** Check transfer unit universal joint slip yokes to make sure yokes are free on shaft splines. Replace frozen slip joints.

**c. OIL LEAKAGE AT UNIVERSAL JOINTS.** Check oil seals at universal joints and replace affected propeller shaft joints.

### **53. Transfer Unit**

**a. TRANSFER UNIT DOES NOT RESPOND TO CONTROL LEVER.** Check shifter shaft extensions to determine if extensions are loose on shifter shafts. If loose, tighten and readjust control rods (par. 130). If extensions are not loose, check transfer unit control rods for adjustment and adjust if necessary (par. 130). If transfer unit will not shift properly after checking above operations, check the yokes on the shifter shafts. If yokes are loose on shifter shafts, replace transfer unit or notify higher authority.

**b. TRANSFER UNIT OVERHEATS.** Check transfer unit oil level and, if necessary, add oil to bring level up to full mark on gage. If oil is low, check unit to determine cause for loss of oil. If oil level is too high, drain or siphon until oil is at FULL mark on gage. Too high an oil level will cause excessive foaming which will cause overheating. If transfer unit continues to overheat, check the oil pump operation in the following manner: Open sliding door over transfer unit and remove one of the 1/8-inch pipe plugs from top of case. Start engines, place transfer unit shift lever in NEUTRAL position, and transmission lever in DRIVE. If oil pump is operating properly, oil will flow out of the plug opening. If no oil flows from plug opening, notify higher authority.

**c. GEARS CLASH WHEN SHIFTING.** If gears clash in cold weather, it may be that the transfer unit lubricants have not been warmed up sufficiently. Start engines and place transfer unit shift lever in NEUTRAL and transmission selector lever in DRIVE. Allow engines to run until the transfer unit warms up. Check for proper seasonal grade of lubricant. If gears clash due to improper use of the neutral pedal, review the driving instructions (par. 15). If gears continue to clash, check the transfer unit control linkage and adjust as necessary (par. 130). If gears clash after adjustments have been made, clash is likely to be due to the clutch synchronizers not operating properly. Notify higher authority.

### **54. Controlled Differential**

**a. VEHICLE HARD TO STEER OR STOP.** If vehicle is hard to steer or stop, check steering brake adjustment and adjust as necessary (par. 134b). If brake bands are highly glazed or worn, replace bands (par. 135).

**b. BRAKES REQUIRE FREQUENT ADJUSTMENT.** If vehicle brakes require adjustments frequently, driver should observe driving instruc-

tions (par. 15) to insure proper handling of vehicle. If brakes continue to require adjustments, check brake rims for roughened condition. If found to be rough or damaged, notify higher authority.

## **55. Tracks and Suspension**

*a. SUSPENSION WHEEL TIRE WEAR.* If suspension wheel tires show excessive wear, check track blocks for bent guide or other damage which would have tendency to cut or wear tires. Repair or replace damaged blocks or tracks as necessary (par. 144).

*b. THROWN TRACKS.* If track was thrown, check complete suspension to determine cause. Improper track tension, damaged compensating wheels, foreign matter between track and wheels, or a broken front torsion bar are the most likely causes for the track to be thrown. Adjust track tension (par. 143), replace damaged compensating wheels (par. 145), clean out foreign matter, or replace broken torsion bar (par. 149).

*c. INOPERATIVE TRACK SUPPORTING ROLLER.* Check roller to make certain no foreign matter is caught between track roller and track, or between track roller and support. If roller is free of foreign matter, check bearing adjustment. If bearing has seized, replace roller assembly (par. 151).

*d. INOPERATIVE COMPENSATING WHEEL.* Check compensating wheel to make certain no foreign matter is caught between wheel and track, or compensating wheel support. If wheel is free of foreign matter, check wheel bearing adjustment. If bearing has seized, replace bearings (par. 145).

## **Section XVI. ENGINE DESCRIPTION AND MAINTENANCE IN VEHICLE**

### **56. Engine Description and Data**

*a. DESCRIPTION.* (1) This vehicle is powered with two 90°, V-type, 8-cylinder, 4-cycle, liquid-cooled engines (fig. 48), mounted side-by-side in the engine compartment in the center of the hull. The engine cylinder blocks and crankcase, made in one casting of grey iron, support the crankshaft and camshaft, and enclose the reciprocating parts. Cylinder heads are of cast iron also. The cylinders are arranged in two banks of four each, located 90° apart. Opposite connecting rod assemblies operate side-by-side from the same crankshaft journal.

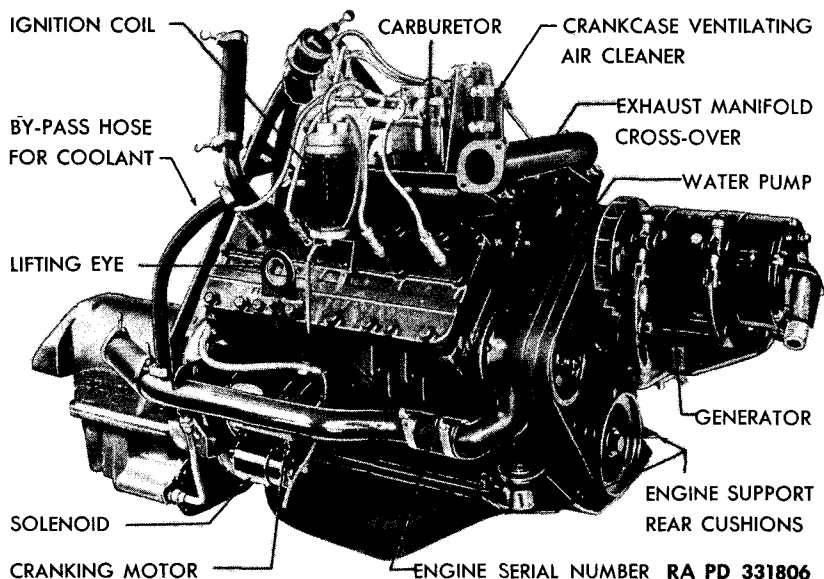
(2) The distributor, ignition coil and wiring, carburetor, intake and exhaust manifolds, and cylinder heads are accessible through the engine compartment hinged air outlet grille. The starter and the engine oil pan are accessible through an inspection opening with removable cover in the hull floor. The belts, water pump, generator

and oil filters are accessible after removing access plates at rear of engine compartment.

(3) The generator end of these engines is designated the front end, even though it faces the rear of the vehicle, and the flywheel end is designated the rear end. The right and left sides of each engine (and transmission) are determined by standing at the transmission and looking toward the generator end. Right- and left-hand engines in the vehicle, however, are designated according to their relation to a man sitting in the driver's seat. The engine on the right of the hull is the right-hand engine. Engine supports, cushions, and attaching brackets and bolts are considered with reference to their position in the hull rather than their relation to the engines. Thus, the support under the transmission is designated as the engine front support, although it attaches to the rear of the engine, and the two supports at the generator end are the engine rear supports.

*b. DATA.*

Bore and stroke.....	3½ x 4½ in.
Compression ratio.....	7.06 to 1.
Cylinder numbering.....	Refer to fig. 74.
Engine make.....	Cadillac.
Engine supports, number of.....	4.



*Figure 48. Engine, three-quarter front view.*

*b.* DATA (Continued).

Firing order-----	1, 8, 7, 3, 6, 5, 4, 2 (fig. 74).
Horsepower, net installed-----	110 @ 3,400 rpm.
Piston displacement (each)-----	346 cu. in.
Valve arrangement-----	L-head.
Weight of engine and transmission assem- bly.	1,166 lb.

## 57. Engine Tune-Up

The operations required for a complete engine tune-up are listed below.

- a.* Clean and adjust or replace spark plugs (par. 75).
- b.* Clean and adjust, or replace contact points (par. 70).
- c.* Check ignition timing (par. 73).
- d.* Clean carburetor auxiliary filters (par. 110).
- e.* Service carburetor air cleaners (par. 109).
- f.* Adjust carburetors (par. 110).

## 58. Operations Performed With Engines in Vehicle

The following operations can be performed without removing the engines from the vehicle (fig. 49) :

- a.* Adjust or replace belts (par. 59).
- b.* Adjust carburetor (par. 110).
- c.* Replace carburetor (par. 110).
- d.* Service carburetor auxiliary filter (par. 110).
- e.* Service cooling system (par. 115).
- f.* Replace cylinder head gaskets (par. 60).
- g.* Replace distributor (par. 70).
- h.* Adjust or replace distributor contact points (par. 70).
- i.* Replace generator (par. 81).
- j.* Replace hose connections (par. 116).
- k.* Replace ignition coil (par. 71).
- l.* Replace ignition condenser (par. 72).
- m.* Adjust ignition timing (par. 73).
- n.* Replace ignition wiring (par. 74).
- o.* Replace manifold gaskets (par. 65).
- p.* Replace manifolds (par. 65).
- q.* Service or replace oil filter (par. 62).
- r.* Replace oil filter connections (par. 62).
- s.* Replace oil pan (par. 63).
- t.* Replace oil pump strainer (par. 64).
- u.* Replace signal sending units (par. 97).
- v.* Adjust or replace spark plugs (par. 75).
- w.* Replace starter (par. 77).
- x.* Replace water pump (par. 109).

**Caution:** Do not use a screwdriver or other sharp instrument to pry belts off pulleys, as this may cause nicks or burs on pulleys and shorten life of belts. Remove and install belts by hand.

(3) *Install belts.* Install three new belts over pulleys. Belts are tied in matched sets of three and must not be separated until ready for actual installation.

**Caution:** Never install one new belt with two old belts except in an emergency; belts should always be replaced in sets of three. Connect generator wires (fig. 66).

(4) *Adjust belts.* See c (4) above.

(5) *Install generator and oil filter access plate.* Refer to c (5) above.

(6) *Close engine compartment.* Close engine compartment doors and turn latch handles to locked position.

## 60. Cylinder Head Gaskets

a. *Removal.* (1) *Open engine compartment.* Turn both latches at side of doors to unlocked position and raise doors. A folding prop is hinged to front edge of door and may be used to hold door in open position.

(2) *Drain coolant.* Remove drain cover under transmission by removing four screws. Remove plug at bottom of transmission marked "WATER" (fig. 27). Remove radiator cap to vent system and thereby speed draining.

(3) *Remove spark plugs.* Disconnect spark plug conduits from spark plugs. Using a deep socket wrench, remove spark plugs and spark plug gaskets (par. 75).

(4) *Remove engine unit signal sending conduit (left cylinder head only).* Remove two screws holding engine unit signal sending conduit to left cylinder head. Disconnect wires from units by pulling straight out of units.

(5) *Remove ignition coil and mounting bracket (right cylinder head only).* Disconnect feed wire from resistor terminal at bottom of coil by removing nut and washer.

**Note.** Make sure master battery switch is in the OFF position. Remove two cylinder head screws which hold coil mounting bracket to cylinder head. Position coil and support bracket out of way to provide access to head screws.

**Caution:** Do not link coil or spark plug conduits; disconnect if necessary (par. 75).

(6) *Remove water outlet elbow.* Remove two special screws holding water outlet elbow to cylinder head. Leave outlet elbow attached to hose. On right cylinder head, leave by-pass hose attached to elbow.

(7) *Remove cylinder head.* Remove all remaining cylinder head screws (except the lower row on outside bank of cylinders) and remove



cylinder head gasket. Lower row of screws on outside bank of cylinders have to be unscrewed and removed with the cylinder head.

**Caution:** Support cylinder head while removing last screws to prevent head from sliding down and damaging valves.

*b. Installation.* (1) Install cylinder head gasket. Coat new cylinder head gasket with gasket sealer on both sides and position on cylinder block. Be sure surfaces of block and head are clean and free of carbon or other particles.

(2) *Install cylinder head.* Position cylinder head over gasket, being careful not to damage gasket or valves. Due to the slight clearance between the hull side wall and cylinder head, it is necessary to place the lower row of cylinder head screws and the engine lifting ring on the outside cylinder head before head is lowered into final position. Be sure engine lifting ring is in proper location on cylinder head (fig. 51). Install (but do not tighten) all screws with the exception of the two longer screws that hold the water outlet elbow and the two that attach the ignition coil mounting bracket to the cylinder head.

**Caution:** The two screws that hold the outlet elbow to cylinder head have special heads and are longer than the other screws and must not be used in any other position or else cylinder block may be damaged.

(3) *Install water outlet elbow.* Coat a new water outlet elbow gasket with gasket sealer and position on cylinder head. Place outlet elbow over gasket and install the two cylinder head screws with the special heads (long screws).

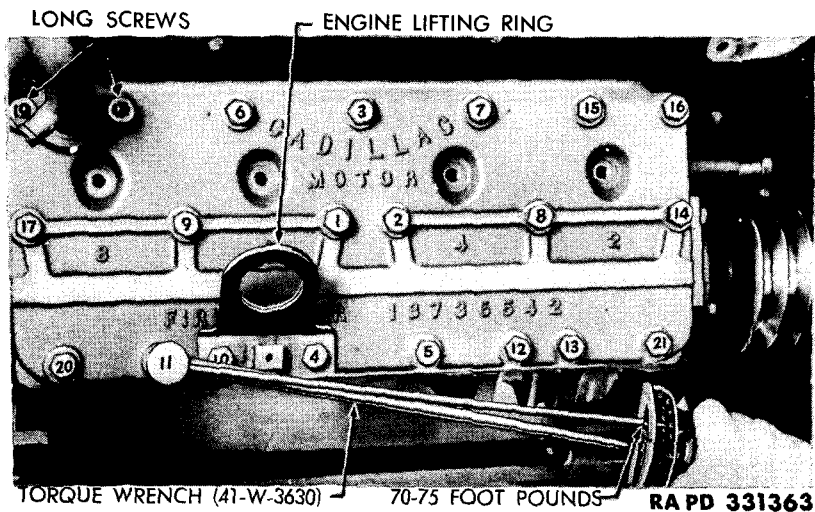
(4) *Install ignition coil and mounting bracket.* Position coil and mounting bracket over the two center holes on cylinder head (right cylinder head only) and install two attaching screws (fig. 69). Do not tighten attaching screws at this time. Connect feed wire to resistor terminal at bottom of coil and connect conduits to top of coil if necessary (par. 74).

(5) *Install engine unit signal sending conduit (left-hand cylinder head).* Position engine unit signal sending conduit on cylinder head and install two attaching screws and washers. Tighten all cylinder head screws to 70 to 75 foot-pounds torque.

**Caution.** Cylinder head screws must be tightened evenly and in the order shown (fig. 51).

(6) *Install spark plugs.* Install spark plug gasket on spark plugs. Using a deep socket wrench, install spark plug and gaskets, tightening plugs to a torque tightness of 7 to 10 foot-pounds. Connect spark plug conduits (par. 74).

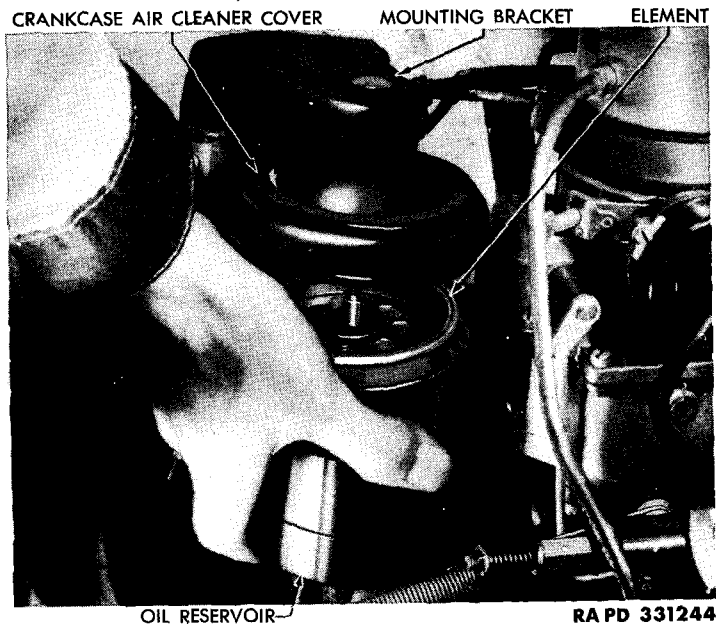
(7) *Refill cooling system.* Install drain plug in bottom of transmission. Coat edges of drain cover and gasket under transmission with sealer and install gasket, cover, and screws. Fill cooling system to proper level. Install radiator cap. Run engine until it reaches



*Figure 51. Tightening cylinder head screws.*

normal temperature and again check torque tightness of cylinder head screws (70 to 75 foot-pounds torque, fig. 51).

(8) *Close engine compartment.* Close door and turn handles to locked position.



*Figure 52. Removing crankcase ventilator air cleaner oil reservoir.*

## 61. Crankcase Air Cleaner

a. DESCRIPTION. Each engine is equipped with a crankcase oil bath air cleaner, mounted on the intake manifold. When engine is operating, air is drawn through the air cleaner, circulated through the crankcase, and then drawn out of crankcase by manifold vacuum. It then passes through the intake manifold and out through the exhaust system.

b. SERVICING. To service and clean air cleaner element, unscrew bowl from cover (fig. 52) and wash bowl and element in dry cleaning solvent. Dry parts thoroughly with air hose, fill bowl to "FULL" mark with clean oil, place element over stud, and reattach bowl to cover.

**Caution:** Be sure gasket is in good condition and in proper position.

## 62. Oil Filter

a. DESCRIPTION. Each engine is equipped with a military, senior-size oil filter mounted in a bracket attached to the front end of the engine. Oil enters the filter through a pipe connected to the main oil header at the front of the engine block. After the oil passes through the filter, it is returned to the engine through another pipe connected to the engine front cover (fig. 54).

b. SERVICING. (1) *Open engine compartment.* Open engine compartment hinged air outlet doors.

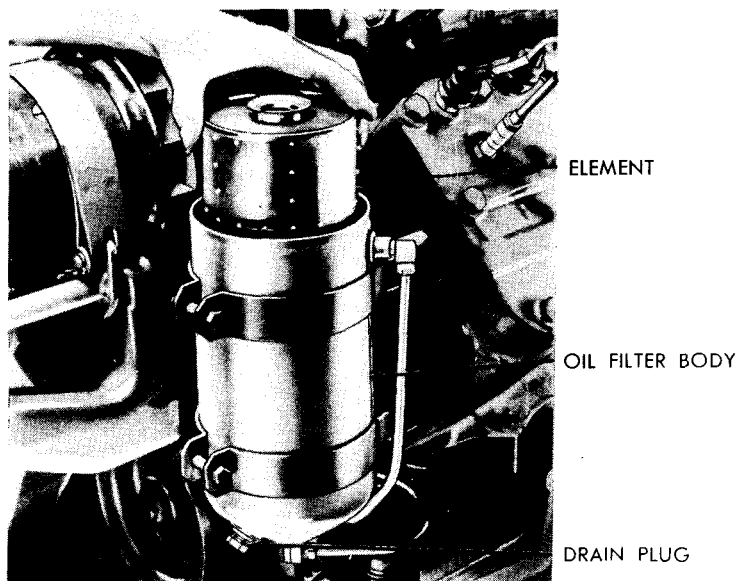


Figure 53. Removing oil filter cartridge.

(2) *Remove generator and oil filter access plate.* Refer to paragraph 59c (3).

(3) *Remove filter element.* Remove hex screw from top of oil filter cover and remove cover and gasket. Discard the gasket. Remove oil filter element by lifting out of filter (fig. 53). If filter element is tight, be careful not to nick the gasket surface on the filter body in prying the element out.

**Caution:** Be sure no oil is allowed to splash on belts in this operation.

(4) *Clean oil filter.* Remove drain plug from bottom of filter and allow old oil to drain. Wash inside of filter with cleaning solvent, wipe dry, and reinstall drain plug. Clean any spilled oil from filter body and hull floor.

(5) *Install new element.* Install new element in filter body. Place new gasket in cover and install cover and tighten screw to 18 to 22 foot-pounds torque.

**Note.** Be sure cover is seated squarely on body before tightening screw.

(6) *Inspect installation.* Run engine for several minutes to allow filter to fill with oil. Inspect for oil leaks. Check engine oil level and add oil if necessary.

(7) *Install generator and oil filter access plate.* Refer to paragraph 59c (5).

(8) *Close engine compartment.* Close engine compartment doors and turn handles to locked position.

c. **REMOVAL.** (1) *Open engine compartment.* Open engine compartment hinged doors.

(2) *Remove generator and oil filter access plate.* Refer to paragraph 59c (3).

(3) *Disconnect oil pipes.* Place rags or container under oil filter to prevent oil running over hull floor. Disconnect inlet pipe at top of filter by unscrewing flared tube nut from elbow. Disconnect outlet pipe at bottom of filter by unscrewing flared tube nut from elbow.

**Caution:** Be sure no oil is allowed to splash on belts in this operation.

(4) *Remove filter.* Remove two nuts and bolts from clamp straps and lift out filter assembly (fig. 54).

(5) *Remove oil pipes from engines.* Disconnect inlet pipe from fitting connected to main oil header at front of cylinder block. Disconnect outlet pipe from fitting on engine front cover.

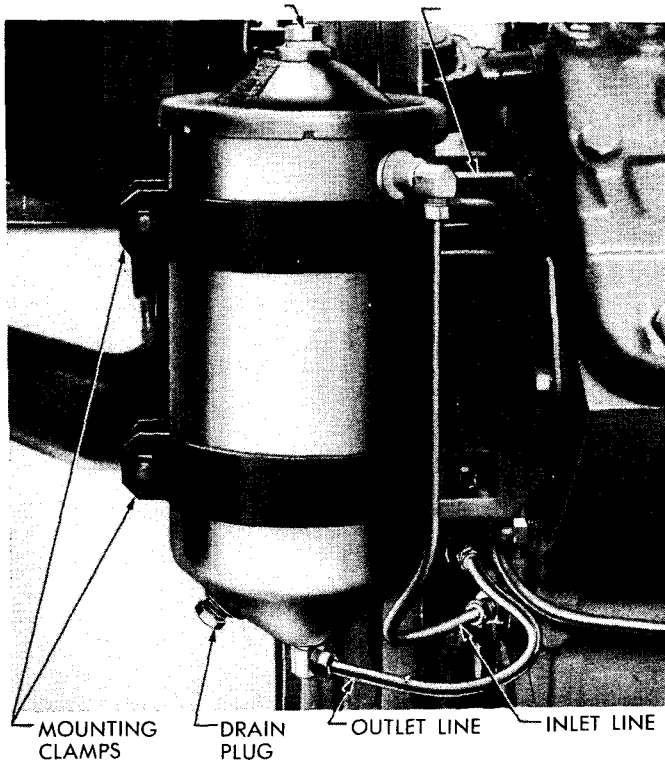
(6) *Remove oil filter mounting bracket.* Remove three nuts and washers holding mounting bracket to front of cylinder block. Remove the bracket.

(7) *Install mounting bracket.* Position mounting bracket over studs on front of cylinder block and install three nuts and lock washers.

(8) *Connect oil pipes to cylinder block.* Connect outlet pipe to fitting on engine front cover and inlet pipe to fitting at main oil header on front of cylinder block.

*Note.* Tighten pipes finger-tight.

(9) *Install oil filter assembly.* Position oil filter assembly in mounting bracket and install two clamp bolts, nuts, and lock washers. Connect outlet pipe to elbow on bottom of filter and inlet pipe to elbow on side of filter. Tighten all connections.



*Figure 54. Oil filter pipes.*

(10) *Inspect installation.* Run engine for several minutes to allow filter to fill with oil. Inspect for oil leaks. Check engine oil level and add oil if necessary.

(11) *Install generator and oil filter access plate.* Refer to paragraph 59c(5).

(12) *Close engine compartment.* Close engine compartment door and turn latch handles to locked position.

### 63. Oil Pan and Gaskets

a. REMOVAL. (1) *Remove hull floor plate.* Remove 18 screws from hull floor plate under engine compartment.

**Caution:** Support rear end of plate while removing last screws to prevent plate from dropping and causing personal injury.

Front end of plate is held up by hooks on cover. Slide plate toward rear of vehicle and lower to ground.

(2) *Drain engine oil.* Remove engine oil pan drain plug and allow oil to drain. Reinstall drain plug with gasket and tighten to 35 to 40 foot-pounds torque.

(3) *Remove oil pan.* Remove 25 oil pan screws. Lower rear end of oil pan and slide pan out through hull floor opening.

(4) *Remove gaskets.* Wash oil pan thoroughly with dry cleaning solvent. Remove all portions of oil pan gaskets from pan and bottom of cylinder block, and discard.

b. INSTALLATION. (1) *Install oil pan gaskets.* Coat gasket surface of cylinder block lightly with joint and thread compound (cement, type-II) to hold gaskets in position. Place gaskets on oil pan or on cylinder block.

(2) *Install oil pan.* Slide front end of oil pan carefully through hull floor opening. Position front end of pan on cylinder block and raise rear end of pan into position. While holding oil pan up against block with one hand, install two or three screws to prevent pan dropping down. Install balance of screws and tighten to 7 to 10 foot-pounds, using a torque wrench.

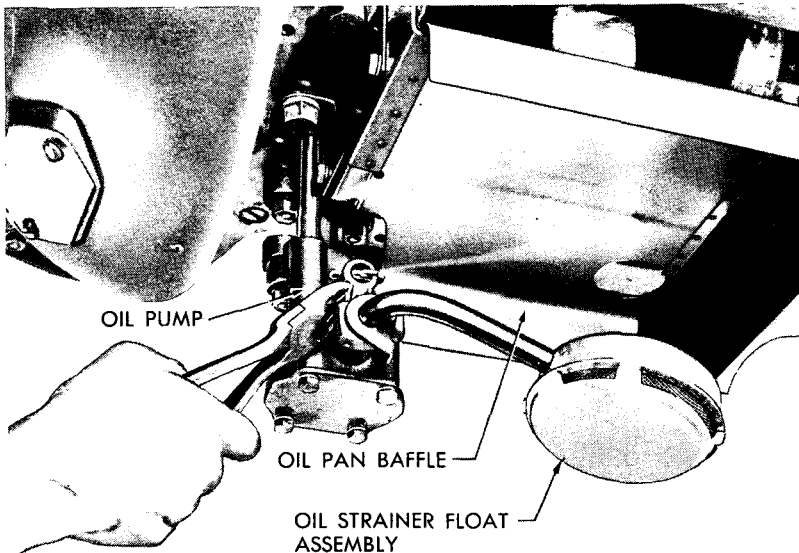


Figure 55. Removing oil pump strainer

(3) *Install hull center plate.* Coat edges of floor plate with joint and thread compound (cement, type II) and place gasket on plate. Raise front edge of plate until hooks on plate rest on hull floor. Raise rear end of plate and line up screw holes with two drift punches. Install floor plate retaining screws.

(4) *Install engine oil.* Refer to lubrication order (par. 32).

## 64. Oil Pump Strainers

a. REMOVAL. (1) *Remove oil pan.* Refer to paragraph 63a.

(2) *Remove oil pump strainer.* Remove cotter pin holding oil pump strainer and float assembly in oil pump body (fig. 55). Slide float and strainer assembly out of oil pump.

(3) *Inspect strainer.* Inspect float assembly to see that oil has not entered the float chamber. Shake assembly to detect presence of oil in float. If oil is found in float, unit should be replaced. If no oil is found in float, wash strainer thoroughly in dry cleaning solvent and blow dirt from strainer mesh.

b. INSTALLATION. (1) *Install oil pump strainer.* Slide oil pump and strainer float assembly into oil pump body. Install cotter pin.

*Note.* Raise and lower strainer assembly several times to make sure it is free and that it will drop down of its own weight.

(2) *Install oil pan.* Refer to paragraph 63b.

## 65. Intake and Exhaust Manifolds

a. REMOVAL. (1) *Open master battery switch.* Refer to paragraph 10.

(2) *Open engine compartment.* Turn latches on engine compartment door to unlocked position and open door.

(3) *Remove carburetor.* Refer to paragraph 110c.

(4) *Disconnect muffler assembly.* Refer to paragraph 113b.

(5) *Remove exhaust connection.* Remove four screws holding exhaust connection to left and right exhaust manifold; lift up connections and discard gaskets.

(6) *Remove ignition wire conduits.* Disconnect conduits at spark plugs. Remove four nuts holding ignition wire conduit support brackets to manifolds. Lay brackets and wires to one side.

(7) *Remove crankcase air cleaner.* Remove two nuts and washers holding engine crankcase air cleaner to intake manifold. Loosen lower hose clamp and remove air cleaner assembly.

(8) *Remove upper rear relay cross shaft.* Remove clevis pin from lever on center of relay cross shaft. Disconnect throttle rods at cross shaft levers. Remove two nuts from relay cross shaft support (fig. 56) and slide cross shaft out of other support.

*Note.* Do not lose springs or washers from ends of cross shaft.

(9) *Remove exhaust manifolds.* Remove remaining nuts and clamps holding exhaust manifolds to cylinder block (fig. 57). Remove manifolds.

(10) *Remove intake manifold.* Bend back lock plates and remove four screws holding fan shaft universal joint to yoke at rear of intake manifold. Bend back lock plates and remove four screws holding fan shaft universal joint to yoke at front of intake manifold. Remove four intake manifold screws (fig. 57) and lift out manifold (fig. 58). Discard gaskets.

b. **INSTALLATION.** (1) *Install gaskets.* Clean gasket surfaces on crankcase and manifolds. Place two new intake and exhaust manifold gaskets on cylinder block.

(2) *Install intake manifold.* Lower intake manifold into position on cylinder block. Install four screws holding intake manifold to cylinder block. Using a torque wrench, tighten screws to 25 to 30 foot-pounds. Connect fan shaft universal joint at rear of manifold and install four screws and lock plates. Bend lock plates over head of screws. Connect fan shaft universal joint at front of manifold and install four screws and lock plates. Bend lock plate over head of screws.

(3) *Install exhaust manifolds.* Place both exhaust manifolds on gaskets and install intake and exhaust manifold clamps and clamp nuts. Using torque wrench, tighten nuts to 25 to 30 foot-pounds.

*Note.* Be sure to install spark plug wire conduit support brackets over the center studs on both sides, and to place carburetor retracting spring clip over left front stud and transmission filler pipe clip over right rear stud.

(4) *Install exhaust connection.* Install two new exhaust manifold connection gaskets on exhaust manifolds and install connection and four mounting screws. Apply antiseize compound (white lead base) to threads of these screws. Using torque wrench, tighten screws to 25 to 30 foot-pounds. After running engine a short time, recheck all manifold screws for proper torque tightness.

(5) *Install crankcase air cleaner.* Slide air cleaner hose over air cleaner front pipe on valve compartment cover. Position air cleaner mounting bracket over mounting studs and install nuts and washers. Tighten lower hose clamp on air cleaner pipe.

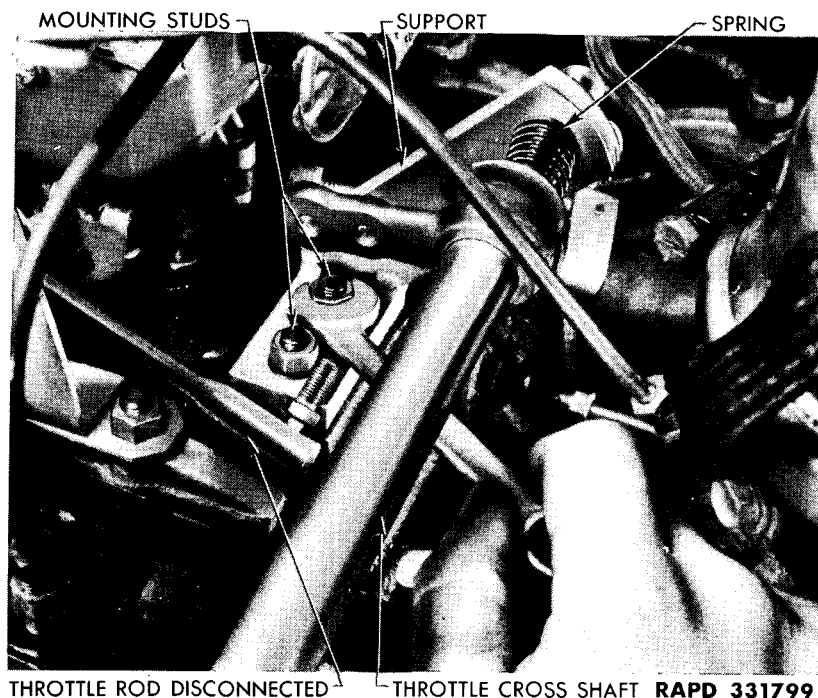
(6) *Install carburetor.* Refer to paragraph 110d.

(7) *Install upper rear relay cross shaft.* Slide end of upper rear relay cross shaft through mounting bracket on intake manifold.

*Note.* Make sure spring and washer are on end of cross shaft before installing in bracket.

Place mounting bracket on opposite end of cross shaft, making sure spring and washer are in position on end of cross shaft. Install mounting nuts and lock washers (fig. 56). Connect rod from upper





*Figure 56. Disconnecting upper relay cross shaft.*

rear relay to lower rear relay by installing clevis pin, flat washer, and cotter pin at upper rear relay. Connect throttle rods to levers on cross shaft. Adjust throttle linkage as explained in paragraph 110e.

(8) *Connect muffler and exhaust pipe.* Refer to paragraph 113.

(9) *Close engine compartment door.* Close engine compartment door and turn latch handles to locked position.

## **66. Engine Mountings—Replacement**

*a. REMOVE ENGINES.* Refer to paragraph 67.

*b. REMOVE ENGINE CUSHION SUPPORTS.* Remove screws and washers holding engine cushion mountings to engine support brackets. Remove rubber cushions.

*c. INSTALL ENGINE CUSHION SUPPORTS.* Place engine cushion mountings over engine support brackets and install screws and washers. Using a torque wrench, tighten screws to 45 to 50 foot-pounds.

*d. INSTALL ENGINES.* Refer to paragraph 68.

## Section XVII. ENGINE REMOVAL AND INSTALLATION

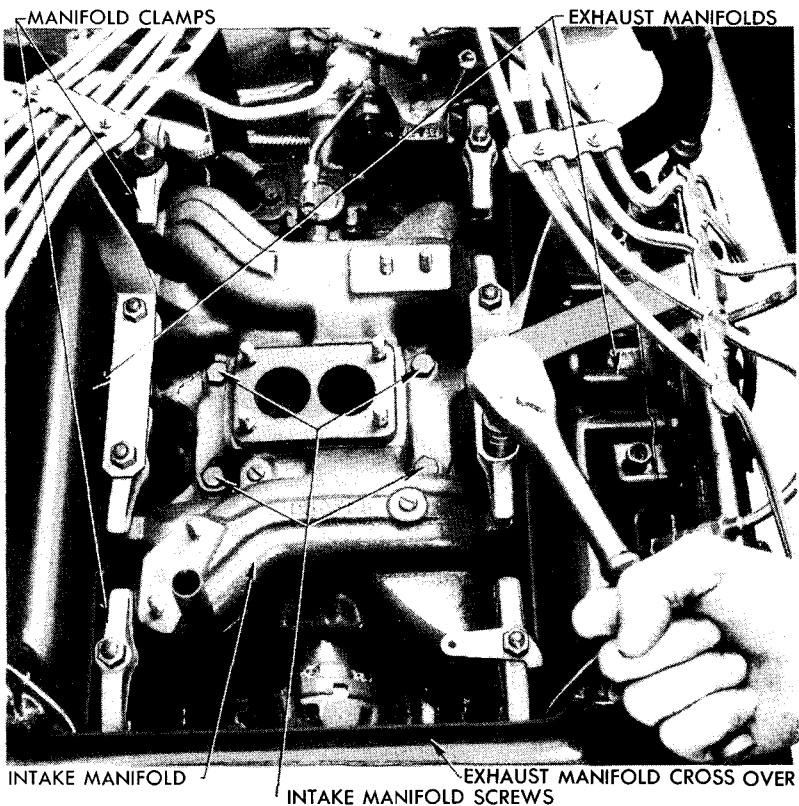
### 67. Engine Removal

*a. AUTHORITY.* Replacement of this major assembly with a new or rebuilt unit is normally a field maintenance operation, but may be performed in an emergency by battery maintenance personnel, provided authority for performing this replacement is obtained from the appropriate commander. Tools needed for the operation which are not carried in organizational maintenance units may be obtained from a higher maintenance unit.

*b. EQUIPMENT.* The only special equipment necessary for removal of the engine is a sling (41-S-3831-300) and a chain hoist.

*c. PROCEDURE.*

*Note.* The procedure that follows applies without change either to a right or left engine.



*Figure 57. Removing exhaust manifold.*

(1) *Open master battery switch.* The master battery switch is located on the front of the bulkhead near the left side wall (fig. 5). Pull out on switch knob and turn about one-quarter turn to lock in open position.

(2) *Position weapon.* Elevate howitzer to about 60°. Traverse howitzer to left or right to provide additional clearance when removing engine.

(3) *Remove engine compartment doors.* Turn latch handles on engine compartment doors to unlock position. Remove two bolts attaching angle plate at rear of doors (in center) and remove plate (fig. 59). Slide doors toward rear and remove from engine compartment.

(4) *Remove shield stowage boxes.* Remove stowage from shield stowage box (left or right), and lift box off side of vehicle.

(5) *Remove water can and holder.* Unfasten strap holding water can to holder and remove can. Remove four screws, lock washers, and nuts attaching water can holder to stowage box support and remove holder.

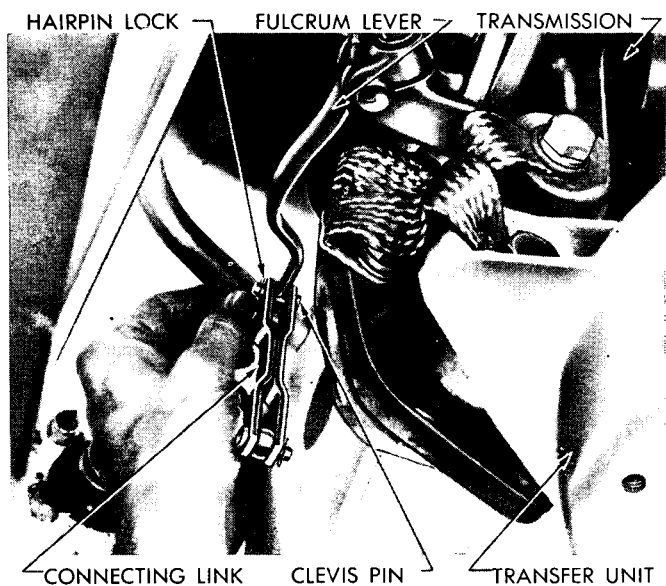
(6) *Remove exhaust pipe extension.* Remove screw attaching exhaust pipe extension to muffler outlet elbow (fig. 60). Remove exhaust pipe extension rear support bolt, washer, and nut, and pull extension out of muffler outlet elbow.

(7) *Remove engine compartment covers.* Remove four bolts attaching cover to hull at rear of engine compartment (fig. 59) and lift off cover. Remove four bolts attaching engine compartment rear plate to bulkhead at rear of engine compartment (fig. 59) and remove plate.

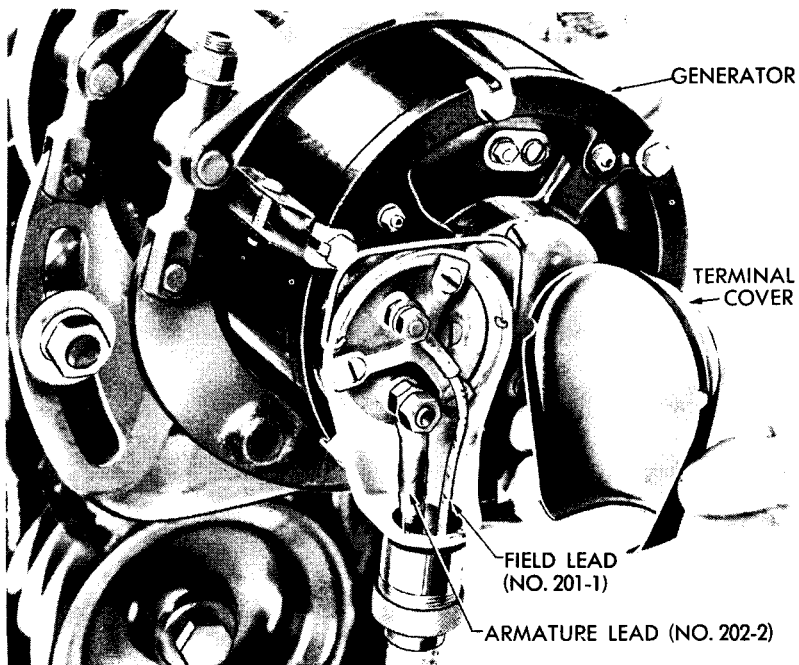
(8) *Drain coolant.* Remove four screws from drain plate under transmission and remove plate. Drain coolant from engine by removing drain plug at bottom of transmission marked "WATER" (fig. 27). Remove radiator cap to vent system and speed draining.

(9) *Remove exhaust pipe and muffler.* Remove two screws, nuts, and washers holding muffler mounting flange to exhaust manifold flange (fig. 61). Remove muffler and exhaust outlet pipe assembly. Discard gasket.

(10) *Remove carburetor air intake elbow.* Disconnect choke thermostat air line at intake elbow and at manifold by unscrewing connections from fitting. Disconnect distributor ventilating line at air intake elbow by unscrewing connection. Loosen air cleaner and elbow assembly clamps (fig. 62). Lift assembly off top of carburetor and slide end off air cleaner hose at engine compartment side wall.



*Figure 65. Disconnecting transmission control rod.*



**RA PD 331266**

*Figure 66. Generator wires.*

(16) *Remove hull floor cover.* Remove screws from hull floor cover.

**Caution:** Support rear end of cover while removing last screws to prevent cover from dropping down and causing injury.

Front of cover is held up by hooks on cover. Slide cover toward rear of vehicle and lower to ground.

(17) *Disconnect hose connections.* Loosen both clamps on each water outlet hose on cylinder head and push hose down on elbow until clear of radiator thermostat housing. Working under vehicle, disconnect lower hose at radiator end of water pump inlet tube.

(18) *Disconnect transmission manual control rod.* Working through bulkhead sliding door opening (fig. 64) or from under vehicle, remove hairpin lock and clevis pin that hold fulcrum lever to connecting link on rear relay (fig. 65).

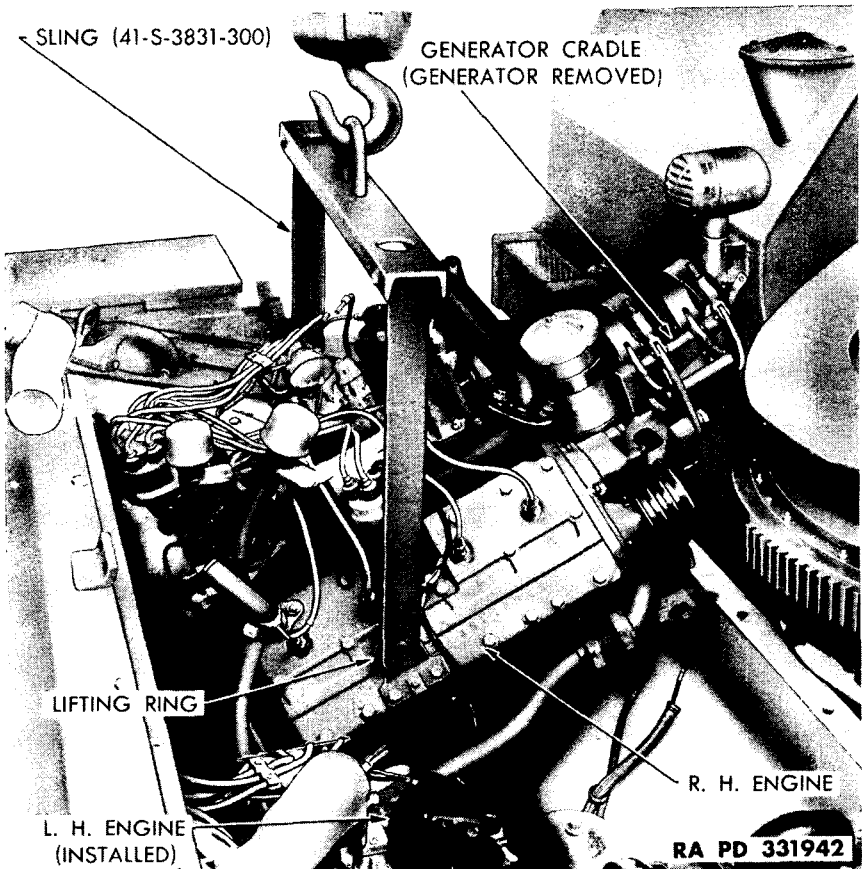


Figure 67. Removing engine.

(19) *Disconnect engine front support.* Working through bulkhead sliding door opening or from under vehicle, remove two cap screws, one on each side, for the engine front support bracket on transmission.

(20) *Disconnect generator and starter conduits.* Remove conduit from generator terminal by unsnapping wire clip from cover. Lift off cover. Unscrew conduit connection at bottom of wire shield box. Remove nuts and washers holding wires to terminals (fig. 66). Lift wires off terminals and pull wires out of box. Disconnect starter feed cable at battery terminal block on rear hull plate by removing cover, removing nut from stud, and lifting off cable.

(21) *Remove generator.* Refer to paragraph 81a.

(22) *Disconnect engine rear supports.* Remove two cap screws, one on each side, from engine rear support brackets.

(23) *Remove engine.* Attach engine sling (41-S-3831-300) to chain hoist and connect to lifting rings on each cylinder head. Raise engine with hoist until it is clear of engine support brackets (fig. 67). Slide engine toward rear of vehicle until splined shaft on universal joint at transmission slides out of transfer unit and splined shaft on fan drive pulls out of yoke. Tilt engine upward at rear just enough so generator cradle will clear rear hull wall; lift engine out of vehicle and place in stand.

(24) *Interchange connecting parts.* If a new engine is being installed, remove fan universal joint shaft assembly from replaced engine and install on new engine. Remove transfer unit input shaft from transmission of replaced engine assembly, and install on new transmission.

## 68. Engine Installation

a. **EQUIPMENT.** The only special equipment necessary for the installation of the engine is the sling (41-S-3831-300) and a chain hoist.

b. **PROCEDURE.**

*Notc.* Engines can be made fully interchangeable, right to left, simply by reversing the exhaust connection.

(1) *Install engine.* Place engine sling (41-S-3831-300) on lifting rings on cylinder heads and connect hoist to sling. Raise engine above and slightly to rear of engine compartment. Lower engine carefully with transmission end tilted down. Line up blind spline on fan shaft with fan yoke. Guide transmission universal joint yoke splines into transfer unit input gear (fig. 68). Lower engine carefully until it rests on engine supports. Remove the sling. Tighten packing nut on fan-shaft yoke.

(2) *Install engine support bolts.* Install two bolts, one on each side, in engine rear support brackets. Working through bulkhead sliding door opening, install two bolts on front support brackets.

(3) *Install generator.* Refer to paragraph 81b.

(4) *Connect generator and starter conduits.* Place feed cable over terminal on terminal block on rear hull plate and reinstall nut and washer. Place cover guard over terminal block and fasten securely. Insert generator feed conduit wires through opening in cover on front of generator and fasten leads to proper terminals (fig. 66). Install nuts and washers holding leads to terminal posts. Slide knurled nut upon conduit and fasten to bottom of box. Place cover on box and lock in position with locking wire.

(5) *Connect and adjust manual control rod.* Place transmission selector lever in "DRIVE" position. Position manual control rod in the middle detent position. If the clevis pin hole in the bottom of the fulcrum lever does not line up with the hole in the connecting link, loosen clamp screw on adjustable rod on transmission rear support (fig. 109) and slide rod in or out until clevis pin holes line up. Tighten clamp screw and install clevis pin and hairpin lock.

(6) *Install hose connections.* Working under vehicle through rear hull floor opening, install lower radiator hose between radiator and water pump inlet tube. Tighten hose clamps. Working above engine, install both outlet hoses between radiator thermostat housing and outlet connections on cylinder head. Tighten hose clamps securely.

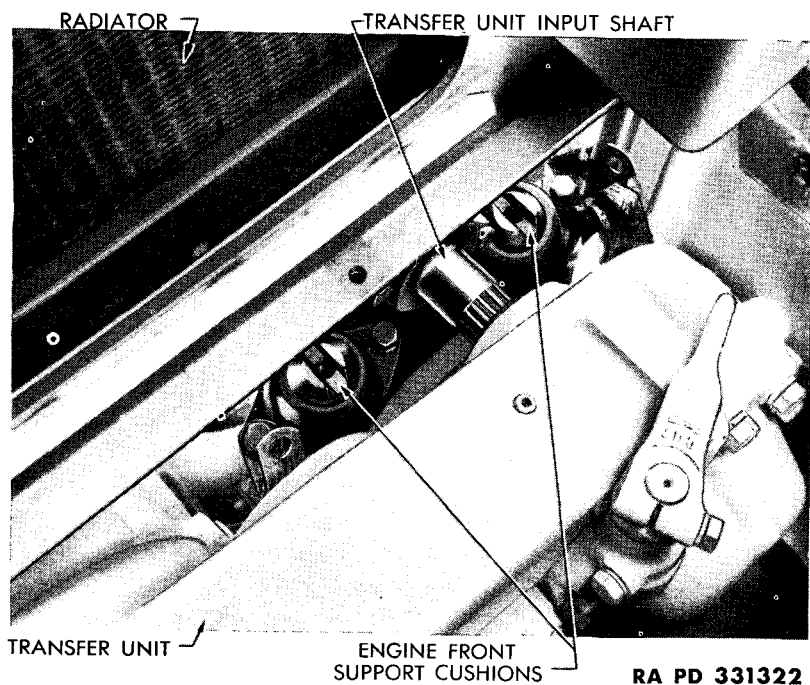
(7) *Connect engine feed conduit.* Line up prongs on engine feed conduit with holes in plug. Push both ends of conduit together and tighten coupling nut.

(8) *Connect tachometer cable.* Slide end of tachometer cable into drive gear in distributor support and fasten cable to support with knurled coupling.

(9) *Connect gasoline line at carburetor.* Slide rubber gasoline hose over end of nipple at auxiliary fuel filter on carburetor and tighten hose clamp securely.

(10) *Connect throttle rods.* Place springs and washers on both ends of throttle cross shaft and position cross shaft first in one bracket and then in other bracket. Fasten bracket to intake manifold mounting studs. Connect lower relay rod to throttle cross shaft lever and install clevis pin and cotter pin. Slide throttle rod ball stud through mounting hole in throttle cross shaft lever and install nut and washer. Adjust throttle linkage as explained in paragraph 110e.

(11) *Install carburetor air intake elbow.* Slide carburetor air intake hose over elbow at engine side wall. Position other end of air intake elbow on top of carburetor. Tighten hose clamps securely. Install choke thermostat air line at intake elbow and left exhaust manifold. Tighten couplings at both ends. Install distributor ventilating air line at intake elbow and tighten coupling.



*Figure 68. Inserting transfer unit input shaft.*

(12) *Install exhaust muffler.* Lower muffler assembly into position next to engine compartment side wall (fig. 61). Position a new exhaust pipe gasket between muffler and exhaust connection. Install two screws, nuts, and washers.

(13) *Fill cooling system with coolant.* Install drain plug in bottom of transmission and install drain cover plate. Fill cooling system with coolant (approximately 40 quarts). Install radiator cap, making sure gasket is in good condition.

**Caution:** When system is filled with cold water, it may be necessary to run the engine until thermostat valve opens and permits system to be completely filled. Be sure to do this if system takes less than 40 quarts. Inspect cooling system for leaks and correct if any are found.

(14) *Adjust carburetor.* Refer to paragraph 110b.

(15) *Adjust ignition timing.* Refer to paragraph 73.

(16) *Check adjustment of both transmissions.* Set the brakes. Run both engines at same time with transfer unit in **HIGH** and transmission lever in **NEUTRAL**. Set hand throttle to run engines at 1,000 revolutions per minute, and move selector lever slowly toward **DRIVE**. By watching tachometers, note position of lever when speed of one engine drops. Rear edge of selector lever should be approximately



one-eighth inch in front of front edge of slot in quadrant when engine speed drops. Continue moving lever until speed of other engine drops. This should be within one-eighth inch additional lever travel. If difference is greater, readjust fulcrum lever of newly installed transmission (par. 121).

(17) *Install lower center hull floor plates.* Coat edges of floor plate with gasket paste, and place gasket on plate. Raise front edge of plate until hooks on plate rest on hull floor. Raise rear end of plate, and line up screw holes with two drift punches. Install floor plate retaining screws.

(18) *Install engine compartment covers.* Place engine compartment rear plate in position and install four attaching bolts (fig. 59). Place engine compartment cover over opening at rear of engine compartment and install four attaching bolts (fig. 59).

(19) *Install exhaust pipe extension.* Slide exhaust pipe extension through extension shield and into muffler outlet elbow (fig. 60) and install attaching screw at outlet elbow. Install exhaust pipe extension rear support bolt at extension shield and tighten securely (fig. 60).

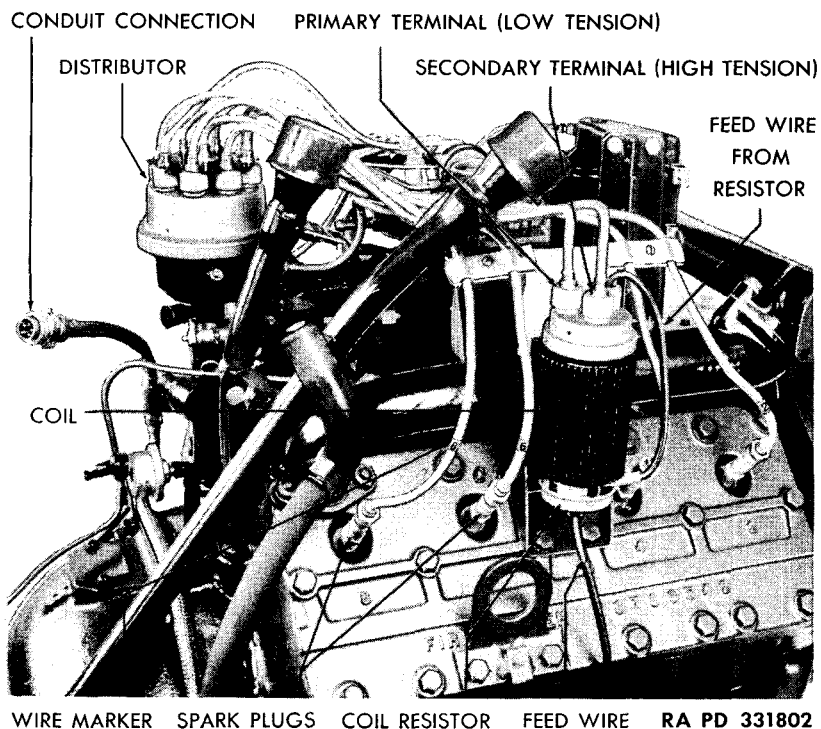


Figure 69. Engine showing ignition units.

(20) *Install engine compartment doors.* Position engine compartment doors over opening making sure pivot at front edge of door is lined up with angle bracket. Place rear angle bracket in position and install two attaching bolts (fig. 49). Open and close doors to see that doors open and close without bind. Close doors and turn latch handles to locked position.

## Section XVIII. IGNITION SYSTEM

### 69. Description and Data

*a. DESCRIPTION.* Two identical, but completely independent ignition systems are used, one for each engine. Each complete ignition system is shielded for waterproofing and to provide effective shielding against radio interference. Each system consists of an ignition coil mounted on a bracket on the center of the right cylinder head (fig. 69); a timer inside the distributor housing; a condenser, also located inside the distributor housing; a distributor which directs the high voltage to each of the spark plugs; the shielded waterproof, two-piece spark plugs; and the necessary shielded metal-clad wiring to connect the ignition units. The wiring circuit diagram of the ignition system is shown in figure 38.

#### *b. DATA. (1) Distributor assembly.*

Contact point gap.....	0.013 to 0.018 in.
Contact spring tension.....	19 to 23 oz.
Direction of rotation (from top).....	Clockwise.
Model number.....	DR-1110612.
Timing adjustment.....	Rotate on mounting.

#### *(2) Ignition coil.*

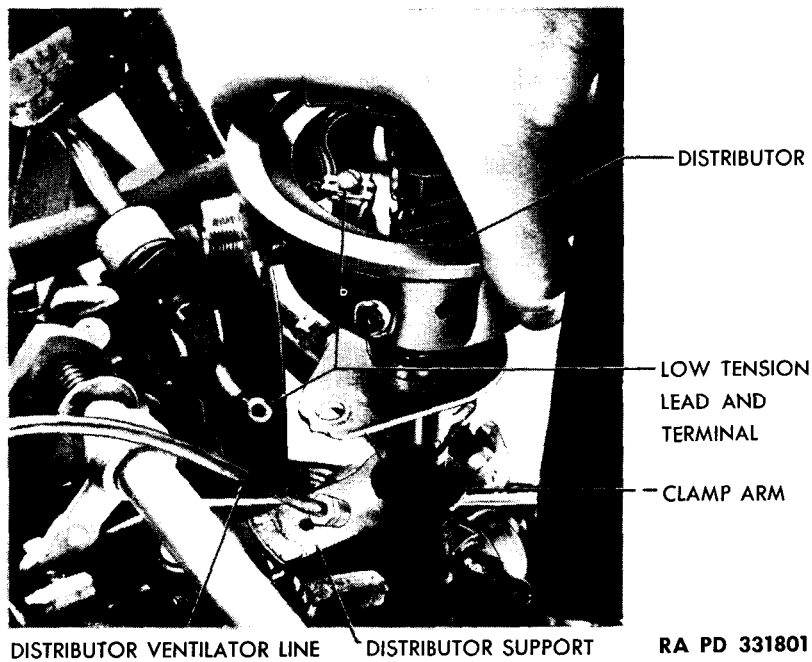
Amperage draw, at idling speed.....	1½ amp.
Model number.....	DR-1115281.
Voltage.....	24.

#### *(3) Ignition condenser.*

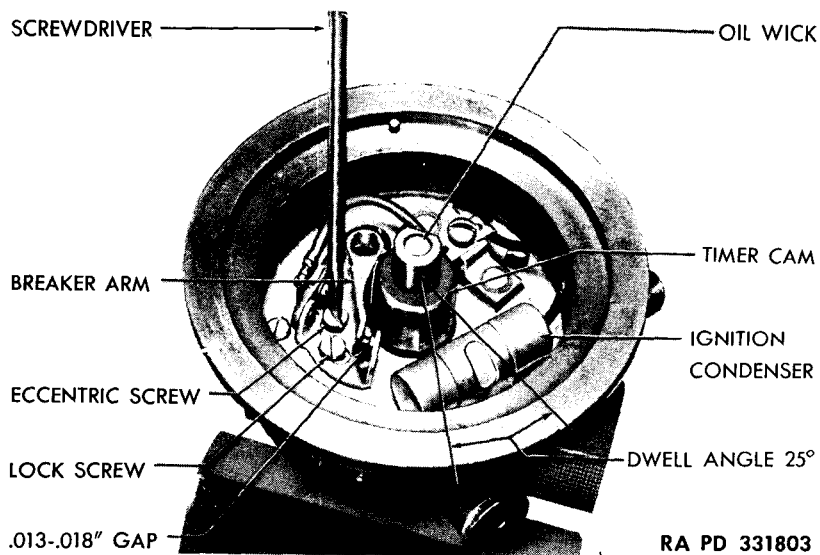
Capacity.....	0.18-0.23 mfd.
Model number.....	DR-1900272.

#### *(4) Spark plugs.*

Gap .....	0.028-0.033 in.
Model number.....	AC-104 (waterproof).
Number used.....	8 per engine.
Thread .....	10-mm.



*Figure 70. Removing distributor.*



*Figure 71. Adjusting contact point gap.*

## 70. Distributor Assembly

*a. REMOVAL.* Open engine compartment hinged air outlet door. Remove distributor cap by loosening clamp screw on sealing band, allow band to drop, and lift distributor cap off distributor.

*Note.* It is not necessary to disconnect wires unless cap is to be replaced.

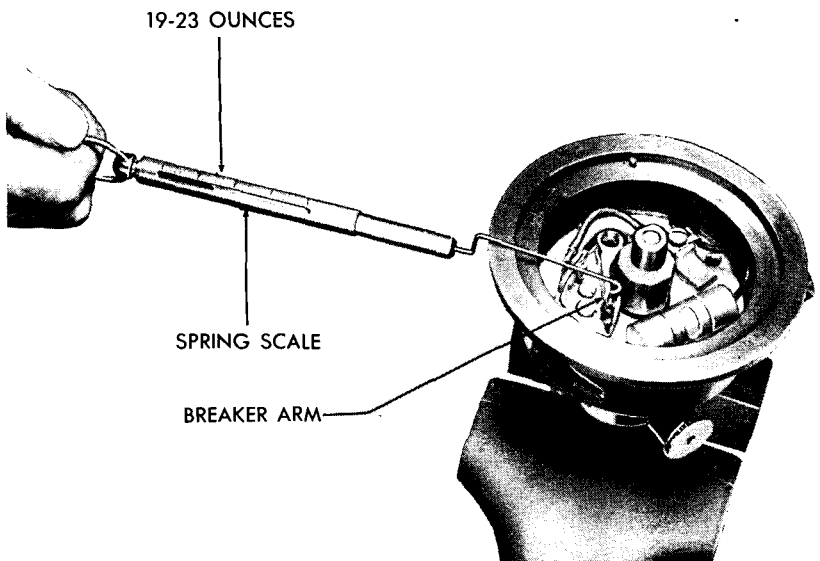
Disconnect the two distributor housing ventilating pipes. One of these pipes is connected to the crankcase ventilating air cleaner and the other to the carburetor air inlet elbow. Disconnect the primary (low tension) wire by unscrewing the coupling at side of distributor and also disconnecting the end of wire inside the distributor at the terminal (fig. 70).

*Note.* The lead from the condenser connects to the same terminal.

Remove cap screw holding distributor clamp arm to the support base, and lift out distributor assembly.

*b. INSTALLATION.* Position complete distributor assembly in support, turning rotor until lug in lower end of shaft meshes with slot in distributor drive shaft. Install cap screw holding clamp arm to base of distributor support. Connect primary (low tension) wire by inserting end through coupling fitting and connecting lead to terminal in distributor.

*Note.* Connect condenser to primary terminal at same time primary connection is made.



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*Figure 72. Checking contact arm spring tension.*

Tighten knurled coupling nut at distributor housing only finger-tight. If pliers are used, too much pressure may be applied and seals at end of wire may be damaged. If wires were removed from top of coil or distributor cap, reinstall and tighten finger-tight.

**Caution:** Pliers must not be used. The metal shell on distributor cap may be distorted or the high-tension towers on the bakelite cap cracked. Reconnect the two distributor housing ventilating pipes and tighten securely. Install distributor cap. Place sealing band in position and tighten clamp screw. If high-tension wires were disconnected from distributor cap, reconnect wires from coil and spark plugs. Check and readjust ignition timing (par. 73). Close engine compartment air outlet door.

c. **CONTACT POINTS.** (1) *Accessibility.* Contact points are accessible for service when the distributor is either on or off the engine, in or out of the vehicle. Figures 71 and 72 show operations being performed on the bench; however, the work may be performed in the same manner in the vehicle. Remove distributor cap and rotor to service contact points.

(2) *Inspecting contact points.* The appearance of contact points reveals whether the points require any service at all and whether they should be cleaned or replaced. Contact point appearance can be classified as follows:

(a) A rough gray surface on the contact points is an ideal condition. Do not clean or replace points with this appearance.

(b) Oil-soaked points usually do not require dressing. Clean points thoroughly, and then see that the source of oil leakage is determined and corrected.

(c) Pitted contact points will not cause ignition failure unless the pitting is severe. Do not replace points because of minor pits or projections. Remove, clean, and smooth up with a carborundum stone.

(d) Oxidized points which have a blue or black scale usually do not require replacement, but the scale must be removed. Oxidized points are usually caused by a faulty coil or condenser. Replace these units if the oxidized condition recurs frequently.

(3) *Cleaning contact points.* If points are badly pitted, burned, or worn, remove and dress carefully with a point dresser until all trace of corrosion or pitting is removed, keeping the surfaces as square as possible. Make sure that the points line up squarely with each other and readjust gap. Retime ignition.

**Caution:** Never attempt to clean points with emery cloth or sandpaper.

(4) *Adjusting contact point gap.* Turn distributor drive shaft until cam is holding points at widest opening. Loosen contact support lock screw with screwdriver, and adjust point opening to a clearance of 0.013 to 0.018 inch (0.015 inch is ideal) by turning eccentric screw

(fig. 71) and checking clearance with feeler gage. Tighten lock screw and recheck clearance to make sure that points remained in adjustment.

(5) *Checking contact arm spring tension.* Check tension of contact arm spring with spring scale hooked over arm as close to points as possible and held at right angles to arm (fig. 72). Correct tension to 19 to 23 ounces. If spring scale is not available, check tension by feel. Tension can be adjusted by loosening screw on breaker support fiber base and sliding the spring either forward or backward, or bending spring.

(6) *Replacing contact points.* Remove lock screw from contact arm support (fig. 71). Loosen screw holding contact arm spring to connector. Remove retainer from contact arm support stud. Lift out breaker lever and contact point support. Place new parts in position, reinstall mounting screws and retainer, and adjust gap.

• *Note.* See that fiber rubbing block on contact arm is parallel to distributor cam.

Install rotor and distributor cap. Retime ignition.

**Caution:** Wipe new parts completely free of any oil with which they have been coated for protection.

## 71. Coil

*a. REMOVAL.* Open engine compartment hinged air outlet door. Disconnect the primary and secondary wire from top of coil by unscrewing the coupling nuts on the shielded wire. Disconnect the feed wire from the resistor at the bottom of the coil. Remove two cap screws and lock washers that attach coil to mounting brackets and remove coil.

*Note.* Ignition coils can be serviced only by replacement of the complete unit.

*b. INSTALLATION.* Position coil on mounting bracket and attach securely with two cap screws and lock washers. Connect primary conduit (low tension) to minus tower and secondary conduit (high tension) to center tower on top of coil. Tighten knurled coupling nuts only finger-tight.

**Caution:** Pliers must not be used. If pliers are used, too much pressure may be applied and coupling nuts and seals at end of conduits will be damaged. Connect feed wire to resistor terminal at bottom of coil (fig. 69).

## 72. Condenser

*a. REMOVAL.* Open engine compartment hinged air outlet door. Remove distributor cap and rotor. Disconnect condenser lead from

primary wire terminal (fig. 71). Remove screw and lock washer holding condenser bracket to breaker plate and lift out condenser.

*Note.* Ignition condensers are serviced by replacement only.

**b. INSTALLATION.** Position condenser and bracket on breaker plate and attach securely with screw and lock washer. Connect condenser lead to primary terminal. Install rotor and distributor cap.

### 73. Timing Adjustment

**a. METHOD.** The correct method of timing ignition is by use of a synchroscope or a timing light.

**b. PROCEDURE.** (1) Warm up engine until a smooth idle of 450 to 475 revolutions per minute can be maintained.

(2) Stop engine and open engine compartment air outlet door.

(3) Remove four screws attaching generator and oil filter access plate to engine compartment cover and remove access plate (fig. 59).

(4) Disconnect high-tension conduit at No. 6 spark plug by loosening coupling nut at plug. Connect spark plug lead from timing light to the spring terminal at end of the insulator on the spark plug conduit. Connect the electrical feed line of the timing light to the resistor terminal at the bottom of the coil, and to any good ground point such as the exhaust manifold stud (fig. 73).

**Caution:** Do not connect a 12-volt timing light to resistor terminal at bottom of coil. If a 12-volt light is to be used, it must be connected to one battery only, to prevent burning out the light due to high voltage.

(5) Restart engine and run at a smooth idling speed at 450 to 475 revolutions per minute. Holding handle of timing light, aim light at pointer on engine front cover. Light should be aimed, and reading should be taken as directly over pointer as accessibility will permit. The timing should be set so that pointer indicator on front cover lines up with IG/A mark on the crankshaft pulley.

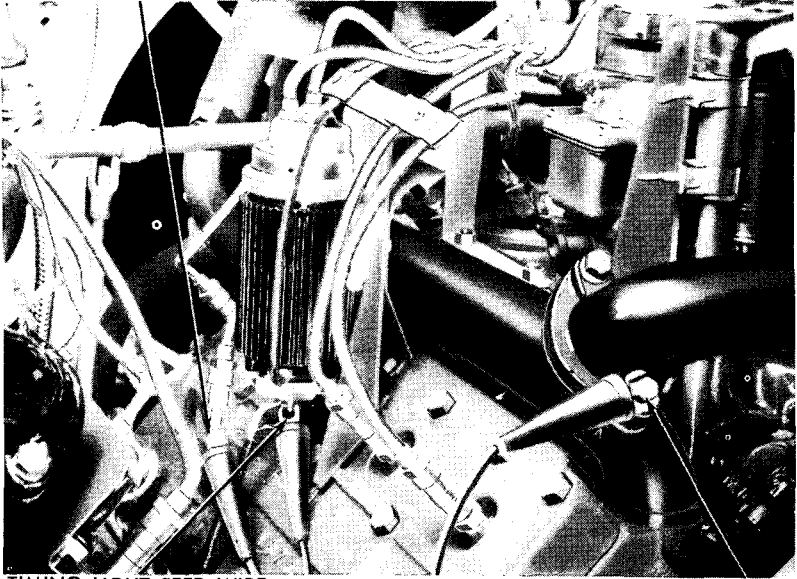
(6) Adjust timing by loosening clamp screw on distributor arm and turning distributor until IG/A mark on crankshaft pulley lines up with pointer on front cover. After proper setting has been obtained tighten clamp screw securely (fig. 73).

(7) Disconnect timing light and reconnect spark plug conduit. Tighten spark plug conduit coupling nut finger-tight, plus approximately one-half turn using a small wrench.

*Note.* Do not force coupling nut.

(8) If detonation is heard with above setting, it indicates that the fuel used is of less than 80 octane value and the spark should be retarded to the barely audible detonation point. It is preferable, however, to obtain correct grade of gasoline.

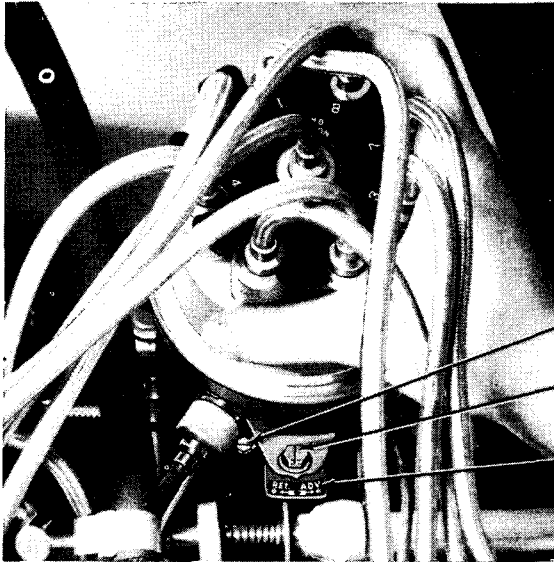
NO. 6 SPARK PLUG CONDUIT TO TIMING LIGHT



TIMING LIGHT FEED WIRE

GROUND

### TIMING LIGHT CONNECTIONS



CLAMP SCREW

HOLD-DOWN SCREW

DISTRIBUTOR  
MARKER PLATE

### SETTING TIMING

RA PD 331800

*Figure 73. Adjusting ignition timing.*

(9) Above timing procedure applies to either right or left engines. Both engines should be checked while timing facilities are available. If a synchroscope or timing light is not available, the timing can be set in the following manner: Connect a 24-volt lamp across the ignition points. Crank the engine by hand using a socket wrench on the crankshaft pulley screw until the IG/A mark on the pulley lines up



with the pointer on the front cover. Rotate the distributor until the light just goes ON. Tighten clamp screw on distributor arm. This method should not be used except when other facilities are not available.

(10) Position generator and oil filter access plate over opening at rear of engine compartment and install four attaching screws (fig. 59). Tighten screws securely.

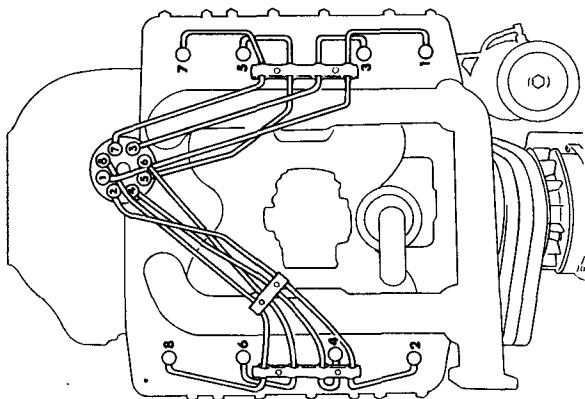
(11) Close engine compartment air outlet door.

## 74. Wiring

*a. REMOVAL OF COMPLETE IGNITION WIRING.* Open engine compartment hinged air outlet door. Disconnect spark plug high-tension conduits by unscrewing coupling nut at upper portion of spark plug. Disconnect conduits at distributor cap by unscrewing knurled coupling nut at each conduit. Remove screws at straps on the conduit supports, loosen straps, and remove wiring.

*b. INSTALLATION OF COMPLETE IGNITION WIRING.* Connect each of the spark plug conduits in turn to the distributor cap, working from the wire markers and following the order indicated (fig. 74).

*Note.* There is a numbered disk, placed on top of the distributor cap through which conduits pass.



*Figure 74. Engine cylinder numbering.*

Install conduits on support straps and connect to spark plugs. Tighten spark plug conduit coupling nuts finger-tight plus one-half turn with small wrench. Do not force coupling nuts. Tighten screws at conduit support straps and connect primary and secondary wires between distributor and coil (par. 71).

*c. INDIVIDUAL WIRES.* Replacement of individual wires can be performed by using the foregoing procedure as a guide.

## 75. Spark Plugs

*a. REMOVAL.* Open engine compartment hinged air outlet door. Disconnect the high-tension conduits at the spark plugs by unscrewing the coupling nut at upper portion of spark plug. Using a deep socket, loosen spark plugs by turning counterclockwise and then remove plugs and gaskets.

*b. CHECKING GAP.* Check spark plug gap with a gage having a round feeler; never with a flat ribbon-type feeler gage. The correct gap is 0.028 to 0.033 inch (0.030 inch is ideal). Gap adjustment must be made by bending side electrode only.

*c. INSTALLATION.* Place new gasket on spark plug and insert plug in engine. Tighten plug to torque tightness of 7 to 10 foot-pounds torque. See paragraph 69*b* for spark-plug specification. Check the condition of the ceramic insulator at end of each spark-plug conduit. Insulator must not be cracked and spring terminal at end of insulator must not be damaged or missing. Connect the correct conduits to each spark plug and tighten finger-tight, plus one-half turn with small wrench. Do not force these connections.

## Section XIX. STARTING SYSTEM

### 76. Description and Data

*a. DESCRIPTION.* (1) There are two independent but identical starting systems, one for each engine. Each system includes a starter mounted on the engine, a solenoid for pinion engagement mounted on the starter housing, a starter relay mounted in the apparatus box on the front of the bulkhead, a feed circuit through the ignition switch, a starter button on the instrument panel, a safety circuit comprising a ground through the transmission warning signal circuit, and the necessary connecting wiring (fig. 37).

(2) To crank an engine, the ignition switch, master switch, and emergency ignition switch must be turned on and the starter button depressed. Current then flows through the two coils of the starter relay, and grounds through the transmission warning signal unit. Energizing the relay coils closes two circuits, one of which leads direct to the solenoid on the starter, while the other provides an independent ground circuit to function in case cranking action opens the transmission warning signal switch. With current flowing through the solenoid, the starter pinion is drawn into engagement with the flywheel ring gear and the circuit for the heavy starting current is closed.

(3) If the starter button should be pressed while the engine is running, no current will flow through the starter relay because the oil

pressure built up in the rotating transmission will keep the warning signal switch open and thereby leave the relay with no ground connection. Whenever the engine stops and transmission oil pressure drops, the switch closes making the ground connection. The circuit can then be completed by pressing the starter button.

**b. DATA.**

**Starter:**

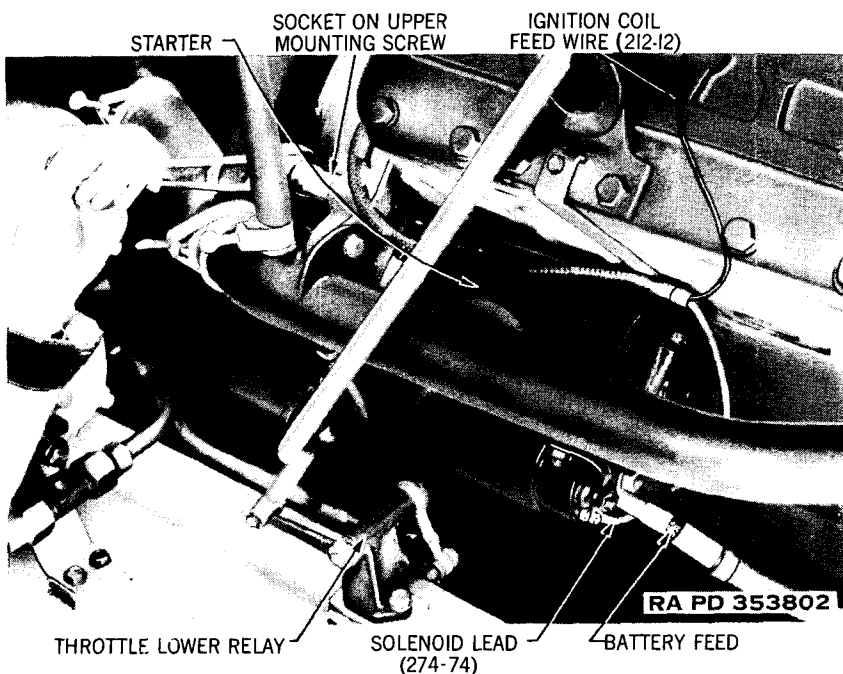
Make.....	Delco-Remy.
Model No. ....	1108568.
Type.....	Four-pole, compound.
Voltage.....	24.

## 77. Starter

**a. REMOVAL.** (1) *Open master battery switch.* Open master battery switches by pulling out on knob and turn about one-quarter turn to lock in open position.

*Note.* Remove starter only after tests (par. 42) indicate that this unit is at fault.

(2) *Remove left hull floor plate.* Remove screws from left hull floor plate. Support rear end of plate while removing last screws to



*Figure 75. Removing starter.*

R.H. STARTER RELAY

RELAY SUPPORT ATTACHING SCREWS

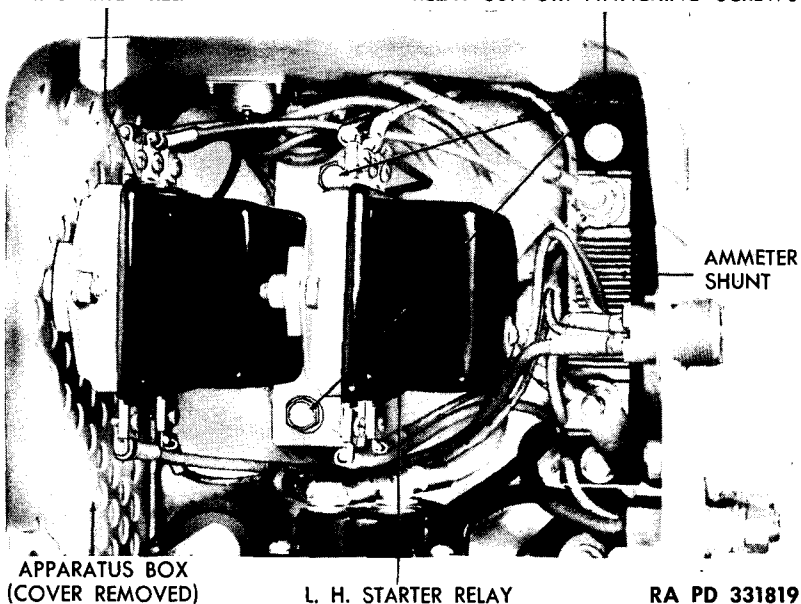


Figure 76. Starter relay mounting.

prevent plate from dropping down and causing injury. Front of plate is held up by hooks. Slide plate toward rear of vehicle and lower to ground.

*Note.* The starters of both engines are accessible through the left hull floor opening.

(3) *Disconnect battery feed cable.* Remove nut from battery feed cable and lift cable off terminal. Disconnect wire from starter solenoid by removing nut and lifting off terminals.

(4) *Remove starter.* First remove upper mounting screw (fig. 75) which passes through flywheel bell housing; then remove bottom screw while supporting weight of starter with other hand. Remove starter through hull floor opening.

*b. INSTALLATION.* (1) *Install starter.* Reaching up through left hull opening, place starter in position in opening on flywheel housing so that dowel on housing fits into cut-out on starter flange. While holding motor in position with one hand, install lower mounting screw through flywheel bell housing and tighten screw. Install and tighten other screw.

(2) *Connect wire and cable.* Connect solenoid switch wire and also battery feed cable to starter, and install retaining nuts and washers.

(3) *Install left hull floor plate.* Place gasket in position on rear hull plate. Raise front end of plate and place hooks on plate over edge

of hull floor. Raise rear end of plate, align screw holes with drift punch and install attaching screws and washers.

## **78. Starter Solenoid**

*a. REMOVAL.* Remove solenoid only after tests (par. 42) indicate that this unit is at fault. Remove starter (par. 77). Remove cotter pin and lever pin holding solenoid plunger link to starter clutch actuating lever. Remove four mounting bolts holding solenoid to starter. Remove bolt holding ground strap to starter. Remove lead wires. Lift solenoid off starter assembly.

*b. INSTALLATION.* Place solenoid in position on starter and install four bolts. Place clutch operating lever in position and lock with new cotter pin. Install lead wires on solenoid.

## **79. Starting Relay**

*a. REMOVAL.* Remove relay only after tests (par. 42) indicate that this unit is at fault. Open master battery switches. Remove eight screws and take off apparatus box cover. Disconnect five wires from relay terminal. Remove two hex nuts, washers, and screws, and remove relay assembly from mounting bracket in apparatus box (fig. 76).

*b. INSTALLATION.* Position relay on bracket in apparatus box and install hex nuts, washers, and screws, with ground wire inserted under inner screw. Reconnect five wires to relay according to diagram (fig. 37). Install apparatus box cover and secure in place with eight screws.

# **Section XX. GENERATOR AND CHARGING SYSTEM**

## **80. Description and Data**

*a. CHARGING CIRCUIT.* Since there are two generators, one on each engine, there are two identical charging circuits, each connected so as to charge both batteries. Each charging circuit consists of a generator, a four-unit generator regulator, and the cables and conduits required to connect these units to the batteries (fig. 39).

*b. GENERATORS.* Two generators are used, one mounted on each engine. Each generator is a 24-volt, 50-ampere, 4-brush, 4-pole, shunt-wound type, with sealed, self-lubricated ball bearings supporting the armature. The generator is clamped in a mounting cradle and bracket, and driven from the crankshaft by three matched belts. The cradle is adjustable to provide correct bolt tension.

*c. GENERATOR REGULATORS.* The two generator regulators are mounted in the apparatus box on the front of the bulkhead (fig. 77).

Each regulator consists of four units: a voltage regulator, a current regulator, a circuit breaker relay, and an actuating relay. These last two relays function together to perform the same duty as a cut-out relay; namely, to open the circuit when generator voltage falls below battery voltage, and to close the circuit when generator voltage is sufficient to charge the battery.

*d. DATA.*

Generator:

Model No.....	DR-1117309.
Output, cold.....	48 to 50 amp.
Rotation, drive-end view.....	Counterclockwise.
Winding.....	4-pole, shunt.

Generator regulator:

Model No.....	DR-1118501.
Type.....	4-unit, 24-volt.

## 81. Generators

*a. REMOVAL.* (1) *Test generator.* Make certain, by following the test procedures given in paragraph 46, that generator requires replacement.

(2) *Open engine compartment.* Elevate howitzer to provide clearance between gun and top of hull. Remove four screws attaching access plate over generator and remove plate (fig. 59). Open master battery switch. Turn handles to unlocked position and open hinged engine compartment doors.

(3) *Remove generator belts.* Loosen generator cradle adjusting nut and allow generator and cradle to drop to lowest position. Loosen knurled packing nut on front fan-shaft yoke at generator pulley end. Slide three drive belts off generator pulley.

**Caution:** Never pry belts off pulley with a screwdriver or other sharp tool, as pulleys may be accidentally nicked and burred.

(4) *Remove generator.* Remove two nuts and spacers holding generator mounting strap clamps to cradle clevis (fig. 78) and swing clamps back. Remove conduit guard and disconnect generator cables. Lift generator out of cradle.

*b. INSTALLATIONS.* (1) *Mount generator in cradle.* Lift generator into mounting cradle on engine, at the same time sliding fan shaft in rear of generator pulley into universal joint yoke splines and seating locating lug on cradle in locating hole in generator housing (fig. 79). Swing generator strap clamps into position on generator and insert clevis in toggle. Install spacer and nuts on clevis and tighten. Reconnect generator cables (fig. 66) and install conduit guard.

(2) *Install and adjust belts.* Lift each belt in turn up into its position on pulley. Tighten knurled packing nut at front fan-shaft universal joint yoke. Raise generator and cradle until there is  $\frac{5}{8}$ - to



Figure 77. Regulator mounting.

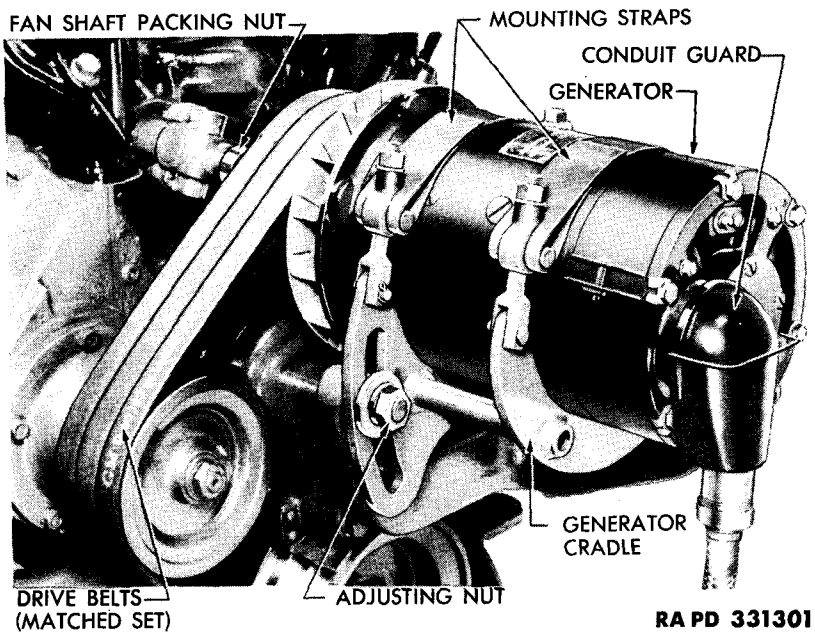
$\frac{3}{4}$ -inch slack in the belts, measured midway between generator and water pump pulleys (fig. 50).

(3) *Close engine compartment.* Reinstall generator access plate. Close engine compartment doors and turn handles to locked position.

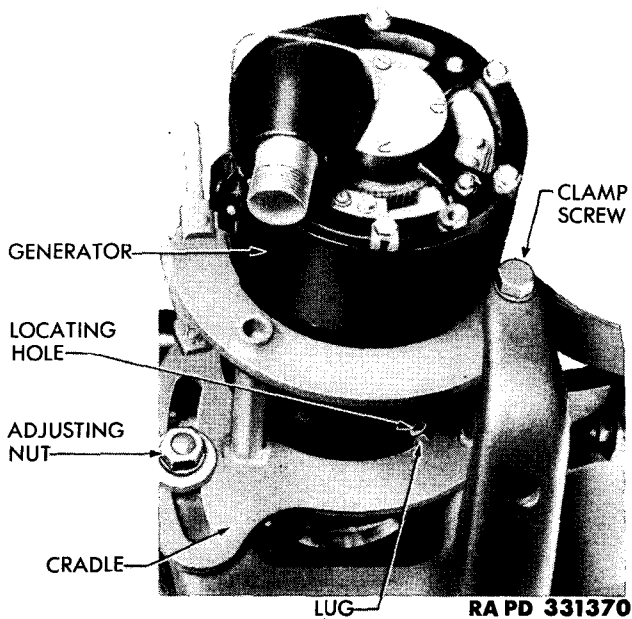
## 82. Generator Regulators

*a. REMOVAL.* Make certain, by following test procedures given in paragraph 46, that generator regulator requires replacement. Open master battery switches. Remove apparatus box cover. Remove six nuts (fig. 77) that hold regulator mounting assembly to apparatus box. Pull generator regulator assemblies out of apparatus box. Remove four bolts holding regulator to mounting bracket. Disconnect three wires at regulator terminals and remove regulator.

*b. INSTALLATION.* Connect three wires to regulator terminals, as shown in figure 77. Close master battery switch, and connect a jumper wire momentarily between "Generator" terminal and "Battery" terminal of regulator. This allows a momentary surge of battery current to flow to the generator and polarize it correctly. Position regulator



*Figure 78. Generator mounting.*



*Figure 79. Installing generator.*



assembly on mounting bracket and install four mounting bolts. Place regulator assemblies in apparatus box and install six nuts holding regulator mounting bracket assembly in box. Install apparatus box cover (fig. 77).

*Note.* Never attempt to readjust generator, regulators; service by replacement only.

## Section XXI. BATTERY AND LIGHTING SYSTEM

### 83. Description and Data

*a. BATTERY.* (1) A 24-volt electrical system is employed. The battery consists of two separate 12-volt, 6-cell units, mounted one on each side of the vehicle, in a compartment in the hull just above the front end of the fuel tank (fig. 80).

(2) The two batteries, one on each side, are connected in series to provide the 24-volt potential. The circuit of the battery system is shown in figure 39.

*b. MASTER BATTERY SWITCH.* The master battery switch, located in a box mounted on the left side of the engine bulkhead between the air cleaner and hull side wall (fig. 5), is provided to open the battery ground circuit and thus cut off all electrical circuits.

*c. BATTERY OUTLET.* The battery charging outlet is located in the same box as the master switch (fig. 5). This outlet provides for plugging in a slave cable to another vehicle or to a battery charger when the batteries are too low to function properly. The circuit is shown in figure 39.

*d. LIGHTING SYSTEM.* (1) *Driving lights.* The driving lights consist of two headlights, with blackout marker lights incorporated, a blackout driving light, and two dual-purpose taillights. The left taillight contains a blackout taillight and a double filament combination service tail and stop light. The right taillight contains a blackout taillight and a blackout stop light.

(2) *Blackout driving light.* The blackout driving light when not in use is carried in a bracket mounted on the left hull wall in back of the driver's seat, and is put in use by substituting for the headlight in the left headlight mount. A resistor is inserted in the circuit to reduce the voltage to the light from 24 to 6 volts. This reduction in voltage is necessary, due to the special design of the blackout driving light, in order to obtain the proper illumination. The resistor assembly is mounted behind the instrument panel at the junction of the upper and lower deck of the hull. This circuit is shown in figure 41.

(3) *Instrument panel lights.* There are two lamps in the instrument panel that provide illumination for all the instruments. These lamps are controlled by a rheostat switch located in the upper left-hand

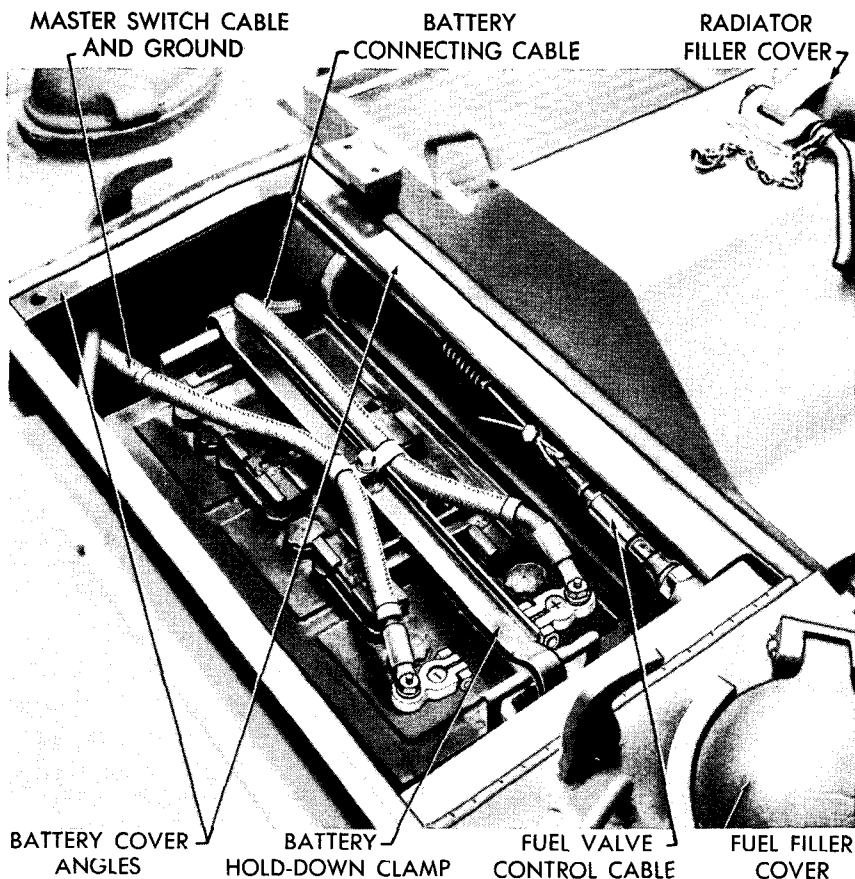


Figure 80. Battery mounting.

corner of the panel. These lamps are available by removal of the access plugs.

(4) *Dome lights.* Two dome lights are provided, located in the driving compartment of the hull, one on the upper deck just above and forward of the assistant driver and the other on the bottom of the emergency ignition switch box. Each dome light has two lamps and two lenses (clear and red).

e. **CIRCUIT BREAKERS.** Seven circuit breakers are incorporated in the electrical system in place of the conventional fuse arrangement. The circuit breakers (except those in the charging circuit) are all of the manual-reset type, which means that the protected circuits can be closed again after the circuit breaker has operated simply by pressing the reset button. The charging circuit breakers are fully automatic. The various circuit breakers are located as follows:

(1) *Lighting.* The circuit breaker for the driving lights is located in the lower left corner of the instrument panel (fig. 6).

(2) *Siren*. The circuit breaker for the siren is also located in the lower left corner of the instrument panel.

(3) *Fuel pump*. The circuit breaker for the fuel pumps is located in the center of the fuel pump switch bracket (fig. 7).

(4) *Ventilator*. The circuit breaker for the ventilator motor is located on the ventilator assembly, on the driver's side, toward the front of the vehicle.

(5) *Hull dome lights*. The circuit breaker for the hull dome lights and the windshield wiper (cold-weather accessory) is located on the front face of the emergency ignition switch box (fig. 12).

(6) *Charging circuit*. Two circuit breakers in generator armature circuit are mounted one on each regulator.

#### *f. DATA. (1) Batteries.*

Type-----	6-cell.
Voltage—each-----	12.
Voltage—entire system-----	24.
Number of batteries-----	2.
Number of plates per cell-----	17.

#### *(2) Master battery switch.*

Type-----	Single-pole, single-throw
-----------	---------------------------

#### *(3) Circuit breakers. (a) Capacity.*

Siren-----	15 amp.
Driving lights-----	30 amp.
Fuel pump-----	15 amp.
Ventilator-----	15 amp.
Dome lights and wiper-----	15 amp.
Generator-----	70 amp.

*(b) Type, all except charging circuit*---- Bimetal disk.

*(c) Reset, all except charging circuit*---- Manual.

*(d) Type, charging circuit*----- Automatic reset.

#### *(4) Lights.*

Blackout marker light-----	3-cp single-contact.
Taillight-----	3-cp double-contact.
Blackout stop lights-----	3-cp.
Service headlights-----	40-watt.
Type-----	Sealed beam.
Service stop light-----	21-cp double-contact.
Instrument panel lights-----	3-cp single-contact.
Signal lights-----	3-cp double-contact.
Blackout taillights-----	3-cp.
Blackout driving light-----	6-volt with resistor.
Dome lights-----	6-cp single-contact.
Spotlight, type-----	Sealed beam.

## 84. Batteries

*a. GENERAL.* The service which the using arm can perform on the battery includes recharging or replacement, replacing cables, adding water, checking specific gravity, and cleaning.

*b. CHECKING BATTERIES.* Never use matches or a flame as a light when checking the battery. Distilled or clean water can be added to bring the fluid level just above the battery plates. If the specific gravity of any cell is 1.200 or below, the battery should be recharged. A fully charged battery should have a specific gravity reading from 1.275 to 1.300. Batteries can be charged in the vehicle by connecting on outside source to the battery outlet. Master battery switch must be ON when recharging batteries by this method.

*c. BATTERY TERMINAL CORROSION.* Warm water poured slowly over the terminals will loosen any copper sulphate that has been deposited, so that it can be brushed off and flushed away.

**Caution:** This should never be done with the battery in the vehicle. Battery posts and terminals should be wiped clean with a cloth saturated in an alkaline solution, such as ammonia or a solution of bicarbonate of soda and water. Corrosion can be retarded by applying a heavy coating of general purpose grease (No. 1). If battery fluid has overflowed or has spilled, all affected metal parts should be flushed with an alkaline solution and wiped dry. Remove drain plate on bottom of hull under fuel tanks to allow water to drain from fuel tank compartment.

*d. REMOVING BATTERY CABLES.* The battery connector cable and master battery switch cable can be replaced by the using arm in the following manner: Turn master battery switch to OFF position. Remove battery box cover. Cover is held in place by a lever and cam arrangement. Pull lever to release cam and slide cam and lever to free cover from latch.

*Note.* It is not necessary to remove batteries from vehicle to replace cables.

Remove battery ground cable by removing nut holding cable to battery post, and pulling cable into engine compartment. Back off knurled nut attaching cable to the master switch box and lift out cable. Loosen screws holding connector cable to posts on batteries, and remove cable from attaching clips.

*e. INSTALLING BATTERY CABLES.* Install connector cable in clips on rear of bulkhead, and attach to battery post on each side (fig. 39). Attach master switch cable to switch, thread cable through opening in bulkhead and connect to negative battery terminal post. Install battery box cover.

*f. REMOVING BATTERY.* Turn master battery switch to OFF position. Remove battery box cover. Cover is held by a lever and cam

arrangement. Pull lever to release cam and slide cam and lever to free cover from latch. Remove hold-down bolts and lift battery hold-down out of position (fig. 80). Remove cables from battery posts by loosening bolt in connection. Place cables out of position. Lift battery out of battery box and remove from vehicle.

*g. INSTALLING BATTERY.* Turn master battery switch to OFF position. Lift battery into place in battery box. Connect rear battery cables, following wiring diagram (fig. 39). Install battery hold-down clamps.

**Caution:** Do not draw up hold-down too tightly or battery cell covers may crack. Install battery connector cable and master battery switch cable and tighten securely. Lift battery box cover into position and lock with cam lever.

## 85. Master Battery Switches

*a. GENERAL.* The master battery switch is located on a bracket mounted on the engine bulkhead at the left rear corner of the driving compartment, between the left engine air cleaner and hull side wall.

*b. REMOVAL.* Place master switch handle in "OFF" position (fig. 5). Disconnect ground strap by removing bolt holding strap to hull side-wall. Remove four bolts, two above and two below, that anchor bracket to bulkhead, and pull bracket toward front of vehicle. Remove nut holding cable and/or ground strap to terminals or master battery switch that is to be removed. Remove cable and tape end. Remove screw holding switch handle knob and remove knob. Remove two bolts holding master battery switch in position and remove switch.

*c. INSTALLATION.* Position switch in bracket. Install two bolts through bracket and switch and tighten securely. Remove tape from cable ends and install cables and/or ground strap on switch terminals. Place bracket in position on bulkhead and install four bolts, two above and two below. Install switch handle knob. Connect ground strap to hull side wall.

## 86. Circuit Breakers

*a. GENERAL.* Inoperative circuit breakers can be serviced by replacement only. They should not be disassembled.

*Note.* When replacing circuit breakers, be sure master battery switch is in OFF position.

*b. REMOVAL.* (1) *Dome lights.* Remove four screws holding dome light in position on emergency ignition switch box and lower dome light and bottom cover of box (fig. 12). Remove two screws holding circuit breaker in position in box; remove circuit breaker and disconnect wires.

(2) *Fuel pumps.* Remove four nuts holding control assembly to mounting bracket. Lower assembly to obtain enough clearance to disconnect the two wires and remove two screws holding circuit breaker in the assembly. Remove circuit breaker.

(3) *Lights and siren.* Remove instrument panel (par. 89). Both circuit breakers are now accessible and can be removed by removing two mounting screws for each and then disconnecting wires from terminals.

(4) *Ventilator.* Remove two mounting screws. Remove both wires and remove circuit breaker from assembly.

(5) *Charging circuit.* Remove regulator terminal cover. Disconnect two leads and remove two screws and washers holding circuit breaker to top of regulator box (fig. 77).

c. **INSTALLATION.** (1) *Dome lights.* Install wires on circuit breaker terminals and tighten securely. Install two mounting screws holding circuit breaker in position on emergency ignition switch box. Place dome light and bottom cover in position on box and secure with four screws.

(2) *Fuel pumps.* Install wires, lock washers, and screws on circuit breaker. Place circuit breaker in position on control assembly and install two mounting screws. Position control assembly on mounting bracket and install four nuts.

(3) *Lights and siren.* Install wires, lock washers and screws and tighten securely. Place circuit breaker or breakers in position on panel, install two mounting screws. Install instrument panel (par. 89).

(4) *Ventilator.* Install wires, lock washers, and screws. Position circuit breaker on ventilator assembly and install with two screws.

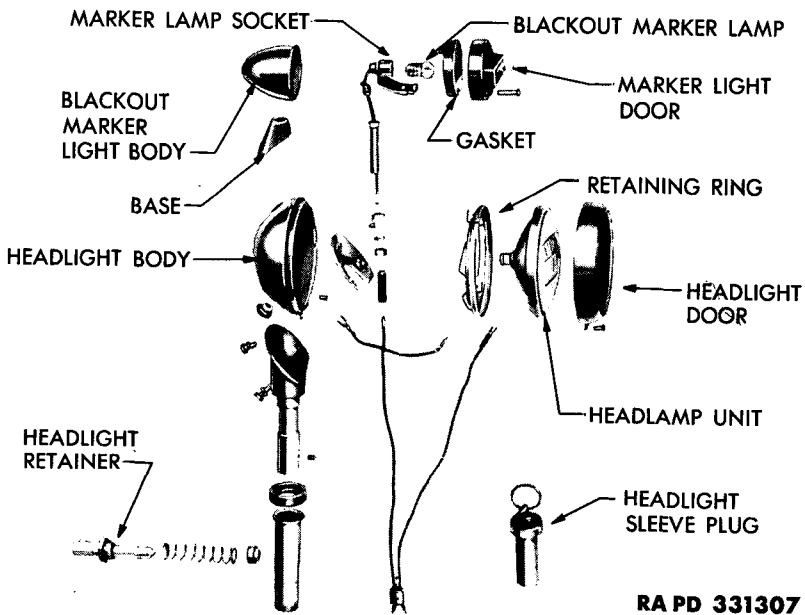
(5) *Charging circuit.* Position circuit breaker on top of regulator box and install two screws and washers. Connect short lead from regulator to right-hand terminal, and lead from generator to left-hand terminal (fig. 77). Install regulator terminal cover.

## 87. Lights

a. **GENERAL.** All taillight and headlight assemblies are composite assemblies of lamps, lenses, and reflectors and are sealed against dirt and moisture. Therefore, the only service operation on the lights is replacement of the sealed assembly. The complete headlight assemblies can be removed for safety in combat zones. Service operations on the lighting switches are covered in paragraph 101.

b. **REMOVAL OF COMPLETE HEADLIGHT.** To remove the headlights, turn locking handles inside hull to the left to loosen. Back off knurled nut on lighting conduit. Remove conduit from headlight assembly. Lift assembly out of mounting.

c. **INSTALLATION OF COMPLETE HEADLIGHT.** See that light switch on instrument panel is "OFF". Place headlight in position on hull



*Figure 81. Headlight assembly—disassembled.*

front plate. Secure in position by turning locking handle. Place lighting conduit in position and tighten knurled nut securely.

*d. REMOVAL OF HEADLIGHT SEALED UNIT.* Remove screw holding headlight door to headlight body (fig. 81). Swing lower end of door outward and lift door from body. Pull sealed unit assembly outward until terminal screws holding wires to sealed unit assembly can be removed. Disconnect wires and remove sealed unit assembly.

*e. INSTALLATION OF HEADLIGHT SEALED UNIT.* Connect red wire in headlight body to terminal on center of sealed unit assembly. Connect black lead in headlight body to sealed unit assembly. Position headlight door body by inserting lug on top of door through slot in top of body. Install screw holding headlight door to body.

*f. REMOVAL OF COMPLETE TAILLIGHT ASSEMBLY.* Remove three screws holding base of taillight assembly to hull. Turn taillight assembly over and remove two nuts and lock washers holding body to base. Slide base away from body, and disconnect both wires from body by turning and pulling connections until they slip out of plugs.

*g. INSTALLATION OF COMPLETE TAILLIGHT ASSEMBLY.* Connect wires to taillight by inserting wires in sockets, and turning them so that they will be locked in place.

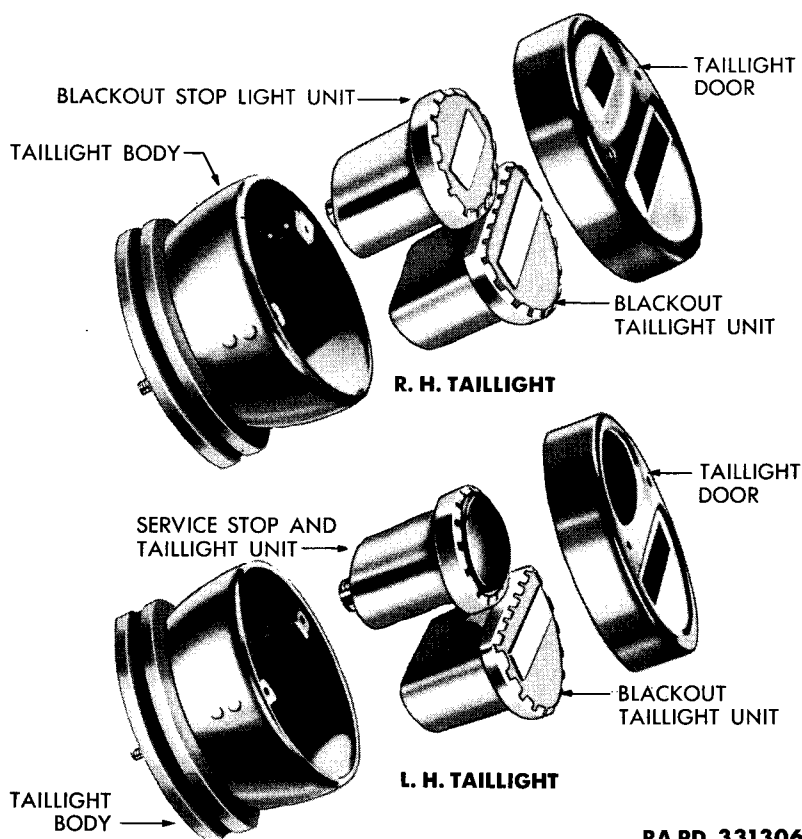
*Note.* Be sure to connect wires to right sockets to assure proper operation of lighting system. Refer to wiring diagrams, figures 40 and 41.

Slide taillight base on body and install two nuts and lock washers. Position taillight on hull and install three screws holding base to hull.

**h. REMOVAL OF TAILLIGHT LAMPS.** Remove two screws holding taillight door to light body and pull door off body (fig. 82). On right-hand taillight, pull the right blackout lamp from the lower portion of the body and the blackout stop lamp from the upper portion of the body. These are sealed assemblies. On left-hand taillight, remove the blackout lamp from the lower portion of the body and the service tail and stop lamp from the upper portion of the body.

**i. INSTALLATION OF TAILLIGHT LAMPS.** On right-hand taillight, position the blackout tail lamp in lower portion of body and the blackout stop lamp in the upper portion of the body. On left-hand taillight, position the blackout tail lamp in the lower portion in the body and the service tail and stop lamp in the upper portion of the body. Position taillight door on body and install two mounting screws and lock washers.

**j. REPLACEMENT OF DOME LIGHT LAMPS.** Remove two screws holding dome light door, and lift off door, rubber gaskets, and both lenses. Replace lamp. Reinstall door, gaskets, and lenses.



**RA PD 331306**

*Figure 82. Taillight assemblies—disassembled.*



## **Section XXII. INSTRUMENTS AND INSTRUMENT PANEL**

### **88. Description**

*a.* The instrument panel is mounted in the driving compartment directly ahead of the driver. It carries the following instruments and controls: two ignition switches, two starter buttons, two temperature gages, two engine and two transmission warning signal lights, two tachometers, a speedometer, an ammeter, the main lighting switch, the panel-light switch, circuit-breaker reset buttons for the lights and siren, and an outlet for connecting auxiliary electrical equipment.

*b.* Diagnosis information on all electrical instruments is given in the section on trouble shooting (par. 47). Replacement instructions on the dial instruments appear in paragraphs 90 through 93; on the lamps in paragraph 93; on the circuit breakers in paragraph 86; on the switches in paragraphs 98 through 102; and on the complete panel in paragraph 89.

### **89. Instrument Panel**

*a. REMOVAL.* Open master battery switches. Working from driver's seat, remove cap screw and lock washer at lower center mounting bracket. Remove two screws and lock washers at upper center mounting bracket, and one at upper right bracket. Loosen upper left mounting screw, slide panel and bracket assembly to the left, and pull forward. Place panel face down in lap, disconnect three flexible cables to speedometer and tachometers, and six flexible electrical conduits. Remove panel from vehicle.

*b. INSTALLATION.* Reinstall three flexible cables for speedometer and tachometers. Reconnect six electrical conduits (figs. 84 and 85), making certain that plugs are correctly indexed. Position panel against and to the left of tapping blocks on hull front plate and slide to the right, engaging the slot at upper left bracket behind flat washer and lock washer of mounting cap screw. Install remaining cap screws; two at upper center bracket, one at upper right, and one at lower center. Tighten all cap screws securely.

### **90. Ammeter**

*a. REMOVAL.* Remove instrument panel from vehicle (par. 89). Remove two terminal nuts (fig. 85) and disconnect lead wires from ammeter. Remove two mounting nuts from terminal studs, slide mounting clamp off studs, and remove ammeter from front of panel.

b. **INSTALLATION.** Position ammeter in opening in panel and install mounting clamp at rear. Install two mounting nuts on terminal studs, position lead wires on studs (fig. 85), and install terminal nuts. Reinstall panel in vehicle.

*Note.* Wires have circuit numbers marked at ends to aid correct assembly.

## 91. Engine Temperature Gages

a. **REMOVAL.** Remove instrument panel from vehicle (par. 89). Remove two terminal nuts and take off two gage lead wires. Remove two mounting nuts, one of which is located on the terminal stud at the side of the gage. Pull mounting clamp back off studs and remove gage from front of panel. This procedure applies for either gage.

b. **INSTALLATION.** Position temperature gage in opening in panel, and place mounting clamp over studs at rear. Install two mounting nuts on studs and tighten snugly. Connect lead wires according to circuit numbers and markings on gage unit. Install terminal nuts. Reinstall panel in vehicle. This procedure applies for either gage.

## 92. Speedometer and Tachometers

a. **REMOVAL.** Remove instrument panel from vehicle (par. 89). Remove two mounting nuts and washers (fig. 85), and remove mounting bracket from rear of instrument. Remove instrument from front of panel. This procedure applies to speedometer and both tachometers.

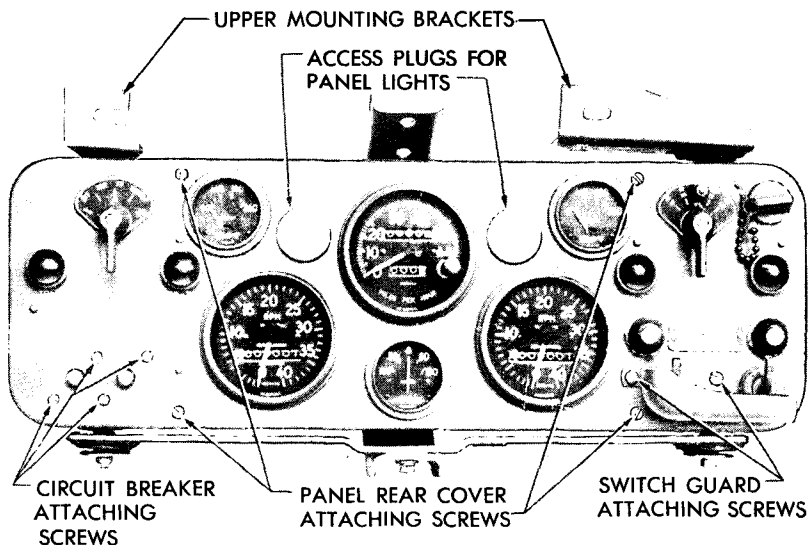


Figure 83. Instrument panel and attaching parts.

*b.* **INSTALLATION.** Position instrument in proper opening in front of panel. Place mounting bracket on rear of instrument with holes for screws and mounting studs properly lined up. Install two mounting screws and washers. Reinstall panel in vehicle.

### **93. Lamps**

*a.* **REMOVAL.** The lamps for the warning signals and for panel illumination can be replaced readily without disturbing the panel itself. First use a screwdriver to pry the access plug for the panel lamps, or the ruby lens for the warning signals (fig. 83) from the panel. Then depress the lamp slightly, turn counterclockwise to release bayonet-type catch, and remove lamp.

*b.* **INSTALLATION.** The lamps used for panel lighting and for warning signals are 24-volt, 3-candlepower. Line up ribs on lamp with slots in socket, depress lamp and turn clockwise until locked securely. Install access plug or ruby lens by snapping into place.

## **Section XXIII. MISCELLANEOUS ELECTRICAL EQUIPMENT**

### **94. Description**

*a.* **GENERAL.** This section includes description and replacement instructions covering all electrical equipment not covered in previous sections. Testing procedures for locating faults in these pieces of equipment are given in paragraph 47.

*b.* **ELECTRICAL WIRING.** Electrical wiring is carried in shielded conduits or cables. Several wires are grouped together and run through a metal sheath with index plugs at each end to form a conduit. This shielding serves to protect the wires from dirt, grease, and other elements which might cause defective wiring. Each circuit is numbered and the circuit numbers are marked on the ends of all wires. These numbers are indicated in the wiring diagrams, figures 37 and 47.

*c.* **SIGNAL UNITS.** The signal sending units consist of an engine temperature gage unit and a heat signal switch mounted at the upper front of the left cylinder head, an engine oil pressure warning signal switch mounted at the rear of the engine block, and a transmission oil pressure warning signal switch mounted at the left rear on the transmission case (fig. 108). The temperature gage unit is essentially an electrical resistor which changes its resistance with changes in temperature. These changes are indicated by the gage on the instrument panel which simply measures the resistance in the gage circuit. The heat signal switch is a gas expansion-type switch in which the gas expands as the temperature increases until at 238° to 242° F. a set of contact points close, forming a completed circuit. The oil-pressure signal switches are simply low-pressure switches. With little or no pressure these switch contacts are closed, permitting the warning signals to

light. The engine oil pressure switch breaks the circuit at a pressure of 8 to 10 pounds. The transmission unit breaks the circuit at 62 to 68 pounds. At all pressures above these, the warning lights are out.

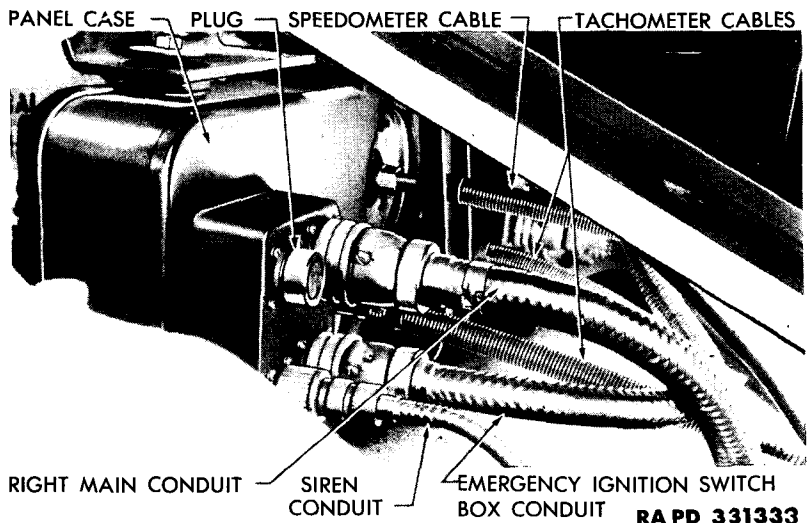
*d. SIREN.* The warning siren is mounted on the front deck next to the left headlight. It is operated by a spring-loaded momentary contact switch on the full floor in front of the driver.

*e. IGNITION SWITCHES.* The two ignition switches, one for each engine, are located in the lower-right corner of the instrument panel (fig. 83) and are protected from accidental operation or damage by a sheet metal guard. The switches have two positions: OFF with the switch levers vertical and ON with the levers turned 90° clockwise.

*f. EMERGENCY SWITCH.* An emergency ignition switch, which controls the feed to the two regulator switches, is mounted in a control box together with the circuit breaker for the dome lights on the hull roof behind and to the right of the driver (fig. 12). This switch must always be kept in the ON position, except in an emergency.

*g. STARTING SWITCHES.* Two starting switches of the push-button type are provided, one for each engine. These switch buttons are located at the lower right of the instrument panel, just above the ignition switches.

*h. LIGHTING SWITCHES.* There are two lighting switches on the instrument panel: one at the upper left for the panel lights, and one at the upper right for the main lighting system. Operation of these switches is covered in paragraph 47. Dome lights in the hull and turret of the vehicle are not controlled by these switches, but by individual switches integral with the lights.



*Figure 84. Cables and conduits at rear of instrument panel.*

i. **FUEL SWITCH.** The fuel switch levers, one each for the right and left fuel tanks, are mounted on the hull roof in front and to the right of the driver (fig. 7). These switch levers not only control the circuits to the electric fuel pumps but also open and close the fuel shut-off valves by means of a cable running back to the valve at each tank.

j. **APPARATUS BOX.** An apparatus box (fig. 86) is mounted on the front of the bulkhead at the extreme right of the driving compartment. It contains the two generator regulator assemblies, the two starter relays, and the ammeter shunt.

k. **VENTILATOR.** The ventilator is located in the hull roof between the driver's and auxiliary driver's doors (fig. 12). The unit is self-contained, and operates by means of a reversible electric motor which can either draw air in or blow it out of the vehicle.

## **95. Conduits, Cables, and Junction Boxes**

a. **REMOVAL.** All electrical conduits are removed in essentially the same manner. Unscrew the connectors at each end and detach connector plugs. Remove the retaining clips, after taking out any stowage items or sheet metal parts that interfere, and remove conduit from vehicle.

b. **INSTALLATION.** Position conduit in hull or turret and install retaining clips. Assemble connectors snugly into place. Observe the following precautions:

(1) Make sure conduits are connected to proper receptacles. Refer to pertinent wiring diagrams (figs. 37 through 47).

(2) When installing connector plugs, make sure that the letters on the plug and receptacle coincide and that the tongue and groove line up. Do not force plugs. If plug is properly lined up, it will slip into receptacle without forcing.

(3) Do not twist or kink conduit. See that all retaining clips are tightened in proper position.

## **96. Apparatus Box**

a. **REMOVAL.** Disconnect the three conduits (fig. 86) at the top and upper side of the apparatus box. Remove the terminal cover and disconnect the five wires (fig. 86) at the ammeter shunt terminal block. Remove the two mounting screws and washers at the lower flange and the three screws and washers at the upper flange, and remove the apparatus box from the bulkhead.

b. **INSTALLATION.** Position the apparatus box on the bulkhead, and install the three upper and two lower mounting screws and washers. Connect the five wires (fig. 86) to the terminal block according to the circuit numbers and install the terminal cover. Connect the three conduits to the correct plugs in the apparatus box.

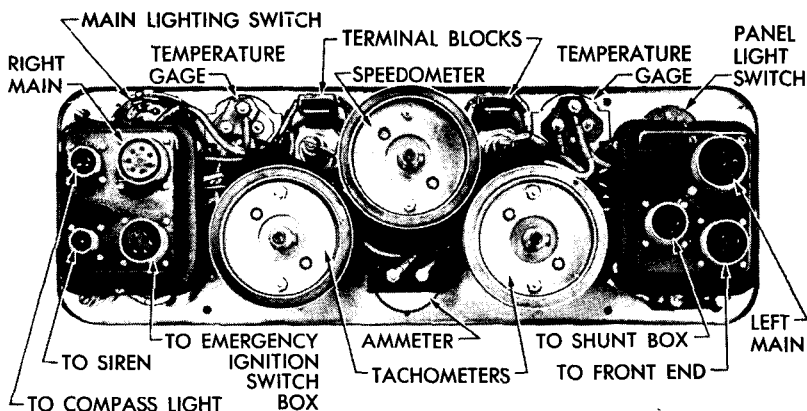


Figure 85. Instrument panel connections—rear cover removed.

## 97. Signal Sending Units

*a. REMOVAL OF ENGINE TEMPERATURE GAGE UNIT.* Make certain by test (par. 47) that engine gage unit is at fault. Open engine compartment door. Disconnect wire to gage unit. Remove water drain plug at bottom of transmission and drain coolant below level of cylinder heads. Remove gage unit from cylinder head.

*b. INSTALLATION OF ENGINE TEMPERATURE GAGE UNIT.* Install gage unit in opening in upper front corner of left cylinder head.

*Note.* Gage unit is cadmium-plated to distinguish it from warning signal unit, which is brass.

Do not use gasket paste or sealer on threads of unit, but tighten sufficiently to secure a good seal. Connect gage wire according to wiring diagram (fig. 45). Refill cooling system and close engine compartment door.

*c. REMOVAL OF ENGINE HEAT SIGNAL UNIT.* Make certain, by test (par. 47) that the signal unit is at fault. Open engine compartment door. Disconnect wire to signal unit. Remove water drain plug at bottom of transmission and drain coolant below level of cylinder heads. Remove signal unit from cylinder head.

*d. INSTALLATION OF ENGINE HEAT SIGNAL UNIT.* Install signal unit in opening in upper front corner of left cylinder head.

*Note.* Warning signal unit is brass to distinguish it from temperature gage unit, which is cadmium-plated.

Do not use gasket paste or sealer on threads of unit, but tighten sufficiently to secure a good seal. Connect signal wire according to wiring diagram (fig. 44). Refill cooling system and close engine compartment door.

e. **REMOVAL OF ENGINE OIL PRESSURE WARNING SIGNAL SWITCH.** Make certain, by test (par. 47), that switch is at fault. Open engine compartment cover. Reaching down from top of vehicle, disconnect wire to switch and then remove switch from L connection at rear of engine V.

f. **INSTALLATION OF ENGINE OIL PRESSURE WARNING SIGNAL SWITCH.** Reaching down from top of vehicle, install switch on L connection, turning down first by hand, and then tightening with wrench only enough to secure a good seal. Connect lead wire to terminal on switch. Close engine compartment door.

g. **REMOVAL OF TRANSMISSION OIL PRESSURE WARNING SIGNAL SWITCH.** Make certain, by test (par. 47), that switch is at fault. Remove cover plate from floor of hull underneath engine. Reaching up through opening, remove dirt from around switch, disconnect lead wire, and unscrew switch.

h. **INSTALLATION OF TRANSMISSION OIL PRESSURE WARNING SIGNAL SWITCH.** Reaching up through opening in hull, install switch, turning down first by hand, and then tightening with wrench only enough to secure a good seal. Connect lead wire to terminal on switch. Reinstall cover plate in hull floor.

## 98. Siren and Siren Switch

a. **REMOVAL OF SIREN SWITCH.** Open master battery switch. Remove two screws and lock washers holding siren switch brackets to

COVER    BULKHEAD    UPPER MOUNTING SCREWS    AIR CLEANER

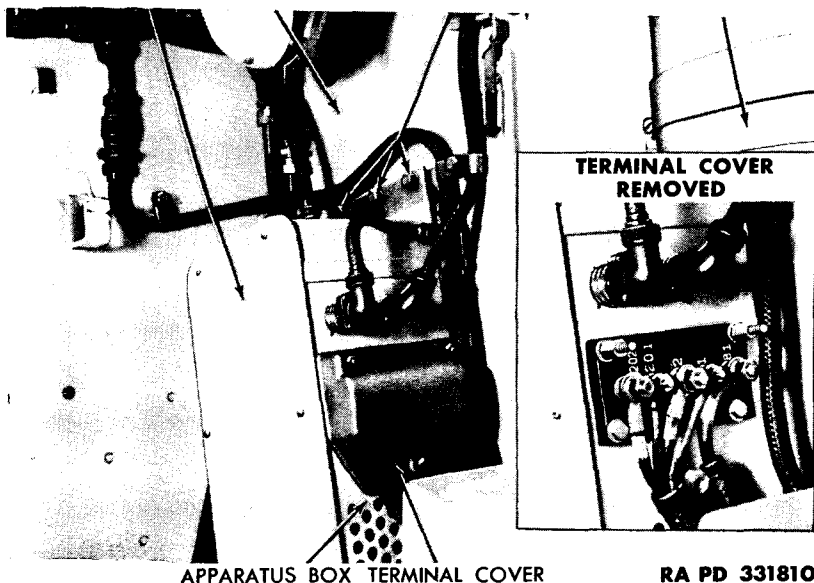


Figure 86. Apparatus box and connections.

hull floor. Turn switch and bracket assembly over, and remove two nuts holding switch conduits to terminals. Loosen siren conduit clip mounting stud nut and slide both conduits out of clip. Remove two screws holding switch to bracket and remove switch.

*b. INSTALLATION OF SIREN SWITCH.* Position siren switch on bracket assembly and install two mounting screws. Connect both siren cables to terminals on switch and tighten terminal nuts.

*Note.* Cables may be installed on either terminal.

Slip both conduits under clip on bracket and tighten clip screw. Position entire assembly on hull floor, and install two mounting screws and lock washers.

*c. REMOVAL OF SIREN.* Remove siren switch from bracket assembly (*a* above) and remove cable to siren by removing terminal nut. Loosen screw holding siren conduit clip to hull, and slip conduit out of clip. Remove nut from lower end of siren mounting tube, and pull siren and conduit out of opening in front hull plate.

*d. INSTALLATION OF SIREN.* If rubber seal at siren opening is damaged or torn, replace it. Slip conduit through opening and lower siren into position. Slide mounting nut over conduit and tighten on lower end of mounting tube. Position conduit under clip and tighten clip. Reconnect conduit to switch and reinstall switch.

## **99. Ignition Switches**

*a. REMOVAL OF IGNITION SWITCH.* Turn master battery switch OFF. Remove instrument panel (par. 89). Take out three mounting screws for right-hand conduit box at back of instrument panel (fig. 85), and pull box out far enough to permit access to rear of ignition switches. Disconnect wires at switch that is to be removed. Turning to face of panel, remove two screws holding guard to panel (fig. 83). Unscrew gnurled nut around switch lever and remove nut. Push switch and lever back and out of panel.

*b. INSTALLATION OF IGNITION SWITCH.* Insert switch in opening from rear of panel, and position with switch lever pointing up. Install knurled nut over switch lever and turn down snugly against face of panel. Install switch guard, tightening mounting screws securely. Turn panel over, and connect wires to switch in accordance with wiring diagram and markings (fig. 38). Position conduit box on mounting studs and install three attaching screws. Install instrument panel in vehicle.

*c. REMOVAL OF EMERGENCY IGNITION SWITCH.* Turn master battery switch OFF. Remove four cap screws and lock washers that hold emergency ignition switch box cover in place and remove cover and dome light from box as an assembly. Disconnect wires to switch, and remove switch after taking out hex nut at front.



*d. INSTALLATION OF EMERGENCY IGNITION SWITCH.* Install switch through opening in switch box and attach with hex nut. Connect wires to switch in accordance with wiring diagram and markings (fig. 38). Position cover and dome light assembly against switch box and install four cap screws and lock washers.

## **100. Starting Switches**

*a. REMOVAL.* Turn master battery switch OFF. Remove instrument panel from vehicle (par. 89). Take out three mounting screws for right-hand conduit box at rear of instrument panel (fig. 85), and pull box out far enough to permit access to starting switches. Disconnect wires at rear of switch to be removed. Turning to face of panel, remove rubber dust seal, loosen the large hex nut surrounding switch button, and remove nut. Push switch back and remove from rear of panel.

*b. INSTALLATION.* Insert switch in opening from rear of panel, and install large hex nut and rubber dust seal at front, turning down until snug against face of panel. Turning to back of panel, connect wires to switch terminals according to wiring diagram and markings (fig. 37). Position conduit box on mounting studs and install three attaching screws. Install instrument panel in vehicle.

## **101. Lighting Switches**

*a. REMOVAL.* Both the panel light switch and the main light switch are removed by the same procedure. Turn master battery switch OFF. Remove instrument panel (par. 89). Disconnect wires from terminals at rear of switch. Remove hex nut from switch lever shaft, remove switch plate, and take switch out from rear of panel. Take screw out of center of switch lever (fig. 83) and remove lever from face of panel.

*b. INSTALLATION.* Insert switch in opening from rear of panel, position switch plate against face of panel, and install retaining nut on switch lever shaft. Place switch lever on shaft and secure in position with round-head screw. Test lever for proper operation. Connect wires to switch terminals in accordance with the wiring diagram (fig. 40). Install instrument panel in vehicle (par. 89).

## **102. Fuel Switches**

*a. REMOVAL.* Turn master battery switch OFF. Disconnect both fuel valve rods at switch levers. Disconnect electrical conduit at emergency ignition switch box. Remove four cap screws and lock washers, and remove switch assembly from hull roof. Remove individual switches or circuit breaker by disconnecting wires and removing attaching screws.

*b.* **INSTALLATION.** Install individual switch or circuit breaker, and connect wires as indicated in diagram (fig. 46). Position switch assembly against hull roof with mounting holes correctly alined, and install four cap screws and lock washers. Connect conduit to receptacle at rear of emergency ignition switch box. Connect fuel shut-off rods to switch levers. Check operation of fuel valves, and readjust rods if necessary.

### **103. Ventilator**

*a.* **REMOVAL.** Turn master battery switch OFF. Disconnect conduit at elbow on left side of ventilator. Remove four cap screws and lock washers around upper mounting flange, and remove ventilator from vehicle as an assembly.

*b.* **INSTALLATION.** Position ventilator assembly on mounting flange in hull roof, install four cap screws and lock washers, and tighten securely. Connect conduit from emergency ignition switch box to elbow on side of ventilator.

## **Section XXIV. RADIO INTERFERENCE SUPPRESSION**

### **104. Purpose**

The purpose of radio interference suppression is to eliminate or minimize electrical disturbances within vehicle which would interfere with radio reception, or would disclose the location of vehicle to sensitive electrical detectors. Therefore, it is important that vehicles with, as well as vehicles without, radios be suppressed properly to prevent interference with radio reception of neighboring vehicles.

### **105. Description**

Suppression is accomplished by use of capacitors (condensers), bonding jumpers (ground straps), and by toothed lock washers. Wiring, which may carry interfering electrical surges to a point where interference will affect radio reception, is shielded. The toothed lock washers and ground straps located throughout the vehicle tend to bind the entire unit together into a solid shield.

### **106. Suppression Components**

Location of suppression components is given below.

*a.* **IGNITION SYSTEM.** (1) The high-tension leads from distributors to spark plugs are inclosed in loose-braid metal shielding which terminate at the ferrules provided at each distributor and spark plug (fig. 89).

(2) The high-tension lead from each distributor to each ignition coil is enclosed in loose-braid metal shielding and terminated at ferrules provided at each distributor and coil.

(3) The low-tension lead from each distributor to each ignition coil is enclosed in loose-braid shielding and terminated at ferrule provided on each distributor and ignition coil.

(4) The low-tension lead, from each ignition coil to each ignition switch, is enclosed in flexible metal-tube shielding, terminating 10 inches from each coil but grounded to each engine block through a pressure clip and at the instrument panel by means of fittings.

(5) The two ignition coils are integrally shielded and incorporate ferrules at electrical connections for terminating shielding of external wiring with the exception of primary lead from coil, where the shielding terminates approximately 10 inches from the coil. One capacitor is built into each coil and is connected to battery terminal of each coil. Each coil is mounted on a bracket which bolts to engine head. Both coils and brackets are grounded by means of toothed lock washers.

(6) Each distributor cap and base is integrally shielded and incorporates ferrules at electrical connections for terminating loose-braid shielding of external wiring. One resistor suppressor is molded in each tower of both distributor caps, each cap having nine towers.

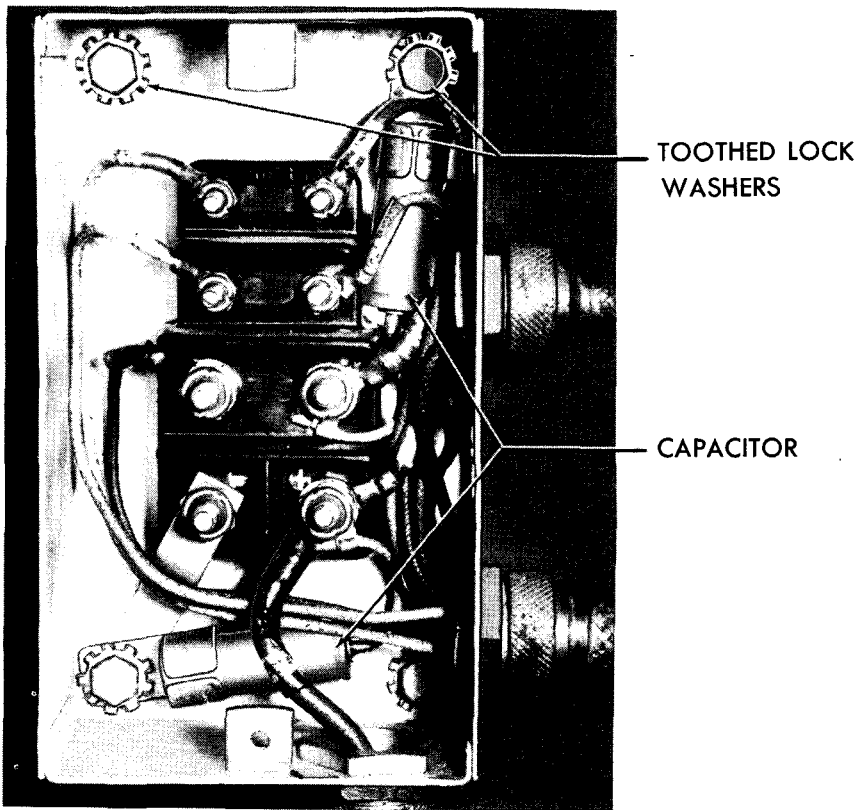
(7) The 16 spark plugs are integrally shielded with suitable ferrules at electrical connections for terminating shielding of high-tension leads. One resistor suppressor is internally mounted in each integrally shielded spark plug.

**b. ENGINE BONDING.** Each engine is bonded to hull by a ground strap from each engine support post (fig. 88) to hull floor. Each engine mounting stand is grounded to transfer case by a ground strap (fig. 65). Each air intake tube is grounded to hull crossmember by a ground strap (fig. 89).

**c. CHARGING SYSTEM.** (1) The two regulators are enclosed in an apparatus box which fastens to hull by means of plated bolts and cleaned surfaces under heads of bolts (fig. 86). The generator terminals are completely covered by a shield which fastens to generator by means of a spring clamp. The armature and field leads between regulator and generator (fig. 88) are jointly enclosed in metal hose shielding, terminated in a fitting at the generator and at shielded terminals at the apparatus box which houses the two regulators (fig. 90).

(2) Two 0.1-Microfarad concentric capacitors are mounted in the housing of each generator and are connected to positive brush terminals of each generator.

(3) One 0.1-Microfarad feed-through capacitor is mounted in each regulator sub-base and connected in lead to armature terminal of each regulator. One 0.1-Microfarad feed-through capacitor is mounted in



*Figure 87. Radio terminal box.*

each regulator sub-base and connected in lead to battery terminal of each regulator. One 0.0019-Microfarad capacitor is mounted in each regulator sub-base and connected in series with a 4-ohm resistor to the field terminal of each regulator. Each regulator is grounded to regulator mounting bracket by ground straps from two of the regulator mounting feet to the mounting bracket (fig. 90). Both regulators are mounted on the bracket and this bracket is welded to the base of the apparatus box.

*d. HOWITZER ELEVATING MECHANISM.* (1) Two 0.1-Microfarad capacitors are mounted on howitzer elevating motor housing, and are connected, one each, to the motor control supply terminals (forward and reverse). The howitzer elevating motor is grounded to gun mount by plated bolts and washers.

(2) Two 0.1-Microfarad capacitors are mounted inside the gun switch box and connected, one each, to the motor control supply terminals (forward and reverse). One 0.1 Microfarad capacitor is mounted

inside the howitzer switch box and connected to the battery terminals. The howitzer switch box is grounded to hull with internal-external plated toothed lock washers under heads of bolts. After vehicle serial No. 70 all wiring leads associated with the howitzer elevating mechanism are enclosed in flexible metal shielding.

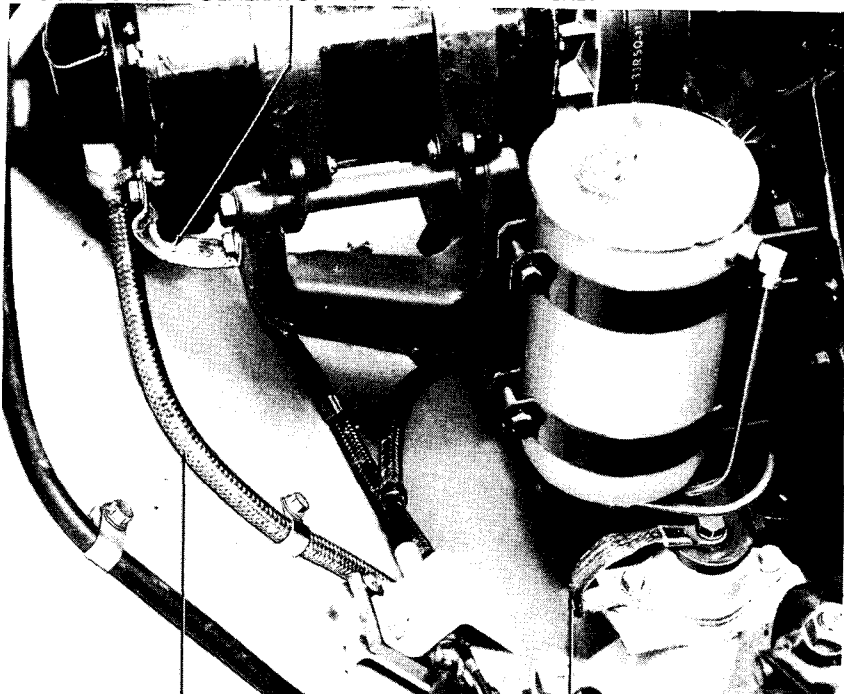
*e. VENTILATING FAN MOTOR.* One 0.5-Microfarad capacitor is mounted in the ventilating fan motor case and connected to switch of motor.

*f. RADIO TERMINAL BOXES.* Two 0.1-Microfarad capacitors are mounted in each of the radio terminal boxes and connected, one each, to the 12- and 24-volt terminals (fig. 87).

*g. BONDING BY GROUND STRAPS.* Ground straps are used at following points:

- (1) Engine support post to hull floor (fig. 88).
- (2) Engine mounting stand to transfer case (fig. 65).
- (3) Air-intake tube to hull crossmember (fig. 89).
- (4) Distributor to hull crossmember (fig. 89).
- (5) Generator to generator bracket (fig. 88).
- (6) Regulator mounting feet to mounting plate (fig. 90).

#### GROUND STRAP—GENERATOR TO MOUNTING BRACKET



GROUND STRAP—ENGINE SUPPORT TO HULL FLOOR  
LOOSE BRAID SHIELDING—ARMATURE AND FIELD LEADS

*Figure 88. Engine support and generator ground straps.*

*h. BONDING BY TOOTHED LOCK WASHERS.* The attaching screws of all clips or clamps which support conduits and pipes and where clips are anchored to tapping blocks are provided with toothed lock washers. Toothed lock washers are used also to bound mechanical parts at the following points:

- (1) Howitzer switch box to hull.
- (2) Howitzer switch box cover to box.
- (3) Howitzer limit switch box cover to box.
- (4) Periscope to hatch door.
- (5) Master switch box to hull.
- (6) Regulator apparatus box to hull.
- (7) Air ventilator assembly to hull.
- (8) Fuel pump mounting plate to fuel tank.
- (9) Fuel pump terminal casting to mounting plate.
- (10) Fenders to hull.
- (11) Bulkhead extension angle to transfer case shield.
- (12) Attaching screws for all electrical nuts.

## **107. Maintenance**

*a. IGNITION SYSTEM.* The following points of attachment must be kept securely tightened:

- (1) Distributor bond strap at distributor end and at hull crossmember.
- (2) All distributor high-tension leads at distributor tower end and coupling nut at spark plug end.
- (3) Spark plug extension (suppressor) nut on spark plug.
- (4) Screws attaching top half of support bracket for high-tension leads.
- (5) Nuts attaching ignition coil-to-coil mounting bracket.

*b. CHARGING SYSTEM.* Capacitors in engine generator housing and in regulators are internally mounted and, in case of failure of capacitors, the generator or regulator should be replaced.

*c. HOWITZER ELEVATING MOTOR AND SWITCH BOX.* The capacitors attached to the howitzer motor leads and to the howitzer switch box leads can be replaced by disconnecting the above leads and replacing defective capacitor.

*d. RADIO TERMINAL BOXES.* Remove terminal box cover and remove capacitors which are connected to positive terminals and anchored by box attaching screws. When new capacitors are installed, make sure that surfaces are clean, and that toothed lock washers are used on attaching screws. Connect capacitors to terminals as shown in figure 87.

*e. WIRING SYSTEM.* Conduit support clip attaching screws must be kept tight and secured by the proper type lock washers. Conduit coupling nuts must be kept properly tightened.

## Section XXV. FUEL AND AIR INTAKE AND EXHAUST SYSTEMS

### 108. Fuel System Description and Data

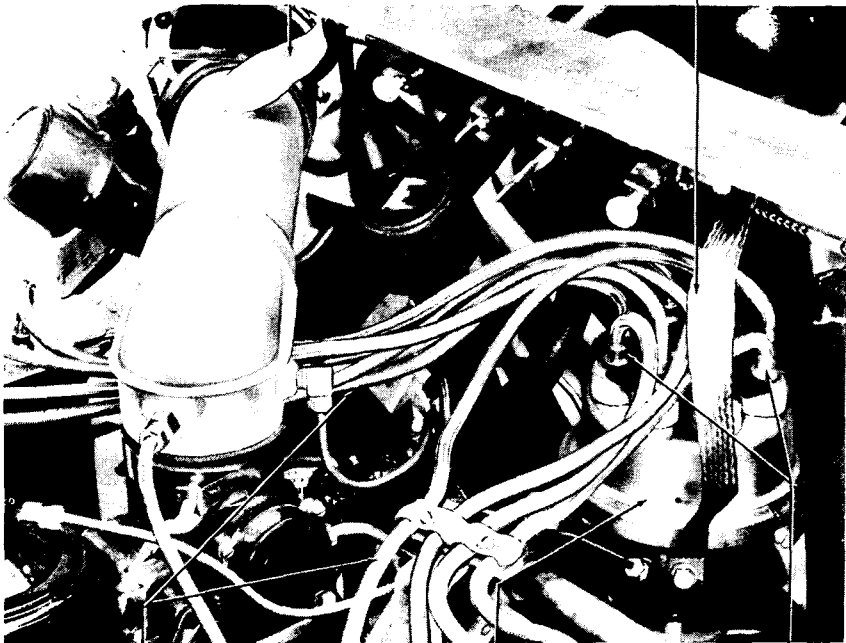
a. DESCRIPTION. (1) The fuel system is illustrated in figure 91. Two fuel tanks, of approximately 55-gallon capacity each, are carried in narrow, deep compartments on each side of the engine compartment.

(2) Two strainers are incorporated in the fuel pump support assembly in the fuel tanks. The first is a cylindrical strainer extending from the top of the fuel tank filler opening to the top of the fuel pump mounting cage (fig. 98). This strains the fuel as it is poured into the tank and also acts as a flame arrester. The second strainer surrounds the fuel pump mounting cage at the bottom of the tank. This strains the fuel in the tank as it passes to the pump, and is self-cleaning due to sloshing action of the fuel.

(3) Each carburetor is equipped with a small disk-type auxiliary fuel filter, which is mounted in a horizontal position on the carburetor float chamber fuel inlet fitting. This filter will retain the small particles of dirt which may pass through the main filter at the bottom of the fuel tank. The filter has a movable bowl to provide a means of cleaning.

GROUND STRAP—DISTRIBUTOR-TO-HULL CROSS MEMBER

GROUND STRAP—AIR INTAKE-TO-HULL CROSS MEMBER



LOOSE BRAID SHIELDING

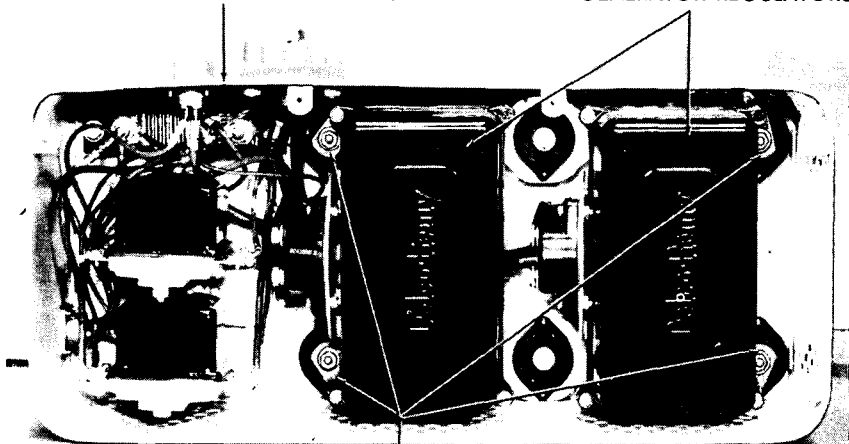
METAL-CLAD DISTRIBUTOR CAP

FERRULE

*Figure 89. Air intake and distributor ground straps.*

APPARATUS BOX (COVER REMOVED)

GENERATOR REGULATORS



GROUND STRAP—REGULATOR FEET TO MOUNTING PLATE

RA PD 331963

*Figure 90. Apparatus box—regulator ground straps.*

(4) A fuel line extends from each fuel pump through the top of the fuel pump support assembly, forward to a check valve, and then to the shut-off valve. From these shut-off valves, a connecting line is carried across the support at the front of the engine compartment. This line contains two T-connections, from which a rubber line extends to the auxiliary fuel filter at the carburetor float chamber (fig. 91). This makes it possible for either tank to supply fuel to both engines.

(5) The flow of fuel and selection of the tank is controlled by a pair of levers and switches at the front center of the driving compartment roof (fig. 7). From each of these levers, a control cable extends back to the shut-off valve and the feed wire for the pump extends back to the terminal on top of the fuel pump support assembly, from which it is carried in an insulated conduit to the pump.

*b. DATA. (1) Carburetor.*

Make.....	Carter.
Type.....	WCD duel downdraft.
Gas line connections.....	$\frac{3}{8}$ -inch hose nipple.
Idle adjustment.....	Screw type.
Flange size.....	$1\frac{1}{4}$ -inch.
Choke type.....	Automatic climatic control.

*(2) Fuel pumps.*

Make.....	Carter.
Location.....	In cage at bottom of fuel tank.
Type.....	Centrifugal, electrically driven.



Number.....	2, 1 in each tank.
Control.....	Switch and manual shut-off valve.
Pressure.....	6 pound.
Octane rating of fuel.....	80.

(3) *Fuel strainers.*

Location.....	Filler support, pump cage.
Make.....	Ripley.
Type.....	Self-cleaning screens.
Number.....	4.

(4) *Auxiliary fuel filter.*

Location.....	Carburetor float chamber.
Make.....	Zenith.
Type.....	Disk-type.
Number.....	One each carburetor.

(5) *Air Cleaner.*

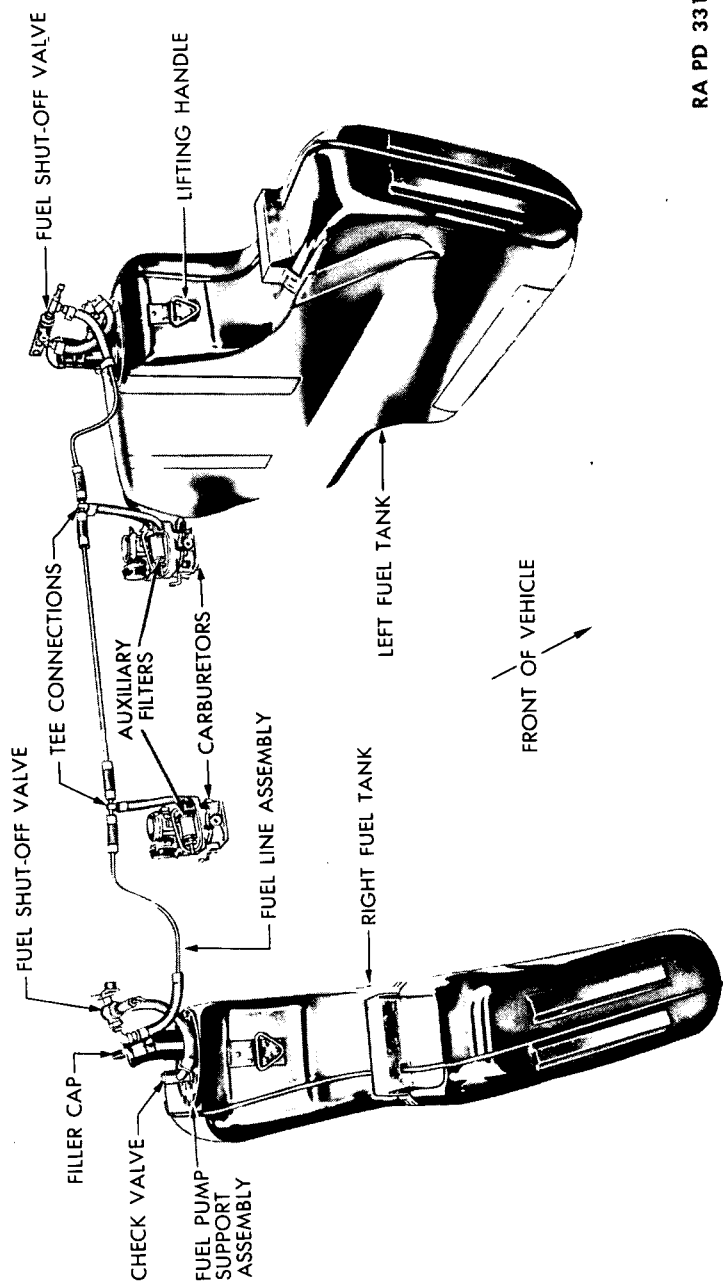
Number.....	2.
Type.....	Oil bath.
Make.....	A. C. or Donaldson.
Filter elements.....	Steel mesh or Tampico fibre.
Reservoir capacity.....	3 quart.
Location.....	Front of bulkhead.

## 109. Air Cleaners

*a. DESCRIPTION.* Two large-capacity air cleaners are provided, one for each carburetor, mounted on the bulkhead at the rear of the driving compartment. These cleaners are of the oil-bath type. Air from the inlet grille above the radiators passes over the oil and through the filtering element and is carried through tubes in the engine compartments to the carburetors.

*b. SERVICING.* Loosen the two wing nuts holding the air-cleaner reservoir to the air cleaner. While supporting the reservoir from bottom, swing out the clamp bolts and lower the reservoir. Remove screen from Donaldson air cleaner by turning screen counterclockwise, then pulling screen down out of air cleaner (fig. 92). Remove element from A. C. cleaners by pulling same downward. Pour out old oil and clean reservoir and screen with dry-cleaning solvent. Dry all units thoroughly with compressed air, if available; fill reservoir to level indicated, using approximately 3 quarts of engine oil (seasonal grade) and reinstall screen and reservoir.

*c. REMOVAL.* The air cleaners are mounted to a bracket on the driving compartment side of the bulkhead by means of two metal straps



RA PD 331852

Figure 91. Fuel system.

that encircle the unit (fig. 92). Working in driving compartment, loosen hose clamp holding air cleaner inlet pipe to air cleaner. Remove screw holding each strap around air cleaner and lift complete assembly from its mounting.

*d. INSTALLATION.* (1) *Check inlet opening.* The air cleaners are interchangeable as rights and lefts by interchanging the plate retained by eight screws with the inlet pipe on the cleaner. The outlet opening on the air cleaner is not removable, but is part of the cleaner itself. The outlet opening must always be connected to the carburetor inlet pipe.

**Caution:** If the air cleaner is installed incorrectly, oil will be drawn out of the air cleaner and into engine.

(2) *Install cleaner.* Coat the inside of the carburetor air intake hose connection with joint and thread compound (cement, type II) and slide outlet on air cleaner into hose. Tighten hose clamp securely. Position two metal straps around air cleaner and tighten screws securely.

## 110. Carburetors

*a. DESCRIPTION.* The carburetors are Carter WCD type, of duel down-draft design, internally vented and fitted with dustproofing seals. Each of the duel barrels in the carburetor supply the fuel mixture to four cylinders through the intake manifolds. Each carburetor

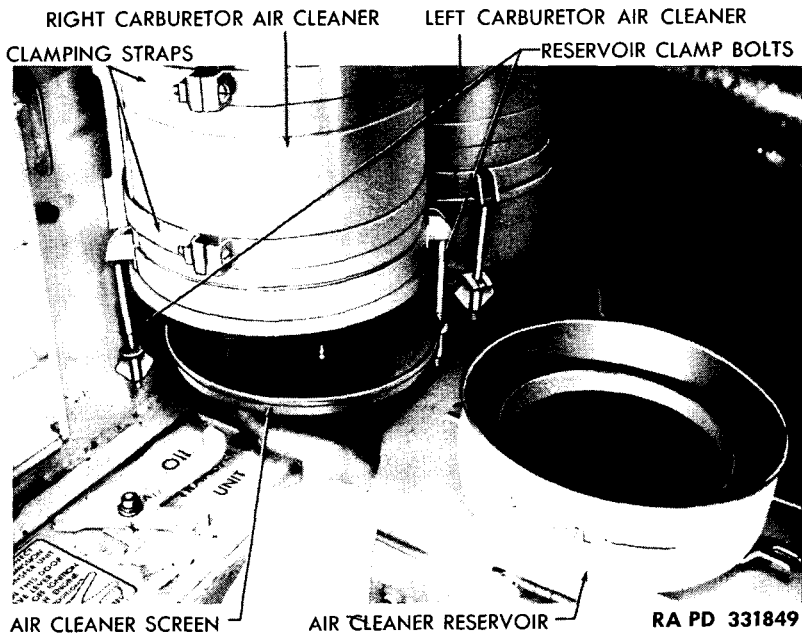


Figure 92. Servicing carburetor air cleaner.

is fitted with an auxiliary fuel filter which is located at the float chamber inlet.

b. **CARBURETOR ADJUSTMENTS.** Test choke shaft with fingers at manual control to see that choke operates freely (fig. 94). Run engines until thoroughly warm; then adjust throttle stop screws (fig. 93) so engine speed is from 450 to 475 revolutions per minute, with the transmission selector lever in "DRIVE" position and parking brakes set. Tighten two idling mixture adjusting screws (fig. 93) as far as possible without forcing; then loosen screws  $1\frac{1}{4}$  turns. Engines should run smoothly without loping or stalling. Readjust screws if necessary. Check to see that choke setting mark on choke thermostat housing is opposite mark on carburetor flange. If necessary, loosen three thermostat housing screws and rotate housing until marks line up (fig. 93). Tighten the screws.

c. **REMOVAL.** Disconnect choke thermostat air line at carburetor and at manifold and remove line. Disconnect distributor ventilating line at carburetor air intake elbow. Loosen hose clamp at carburetor air intake elbow (fig. 62) and lift elbow off carburetor. Make sure both fuel tank control levers (in driver's compartment) are in "OFF"

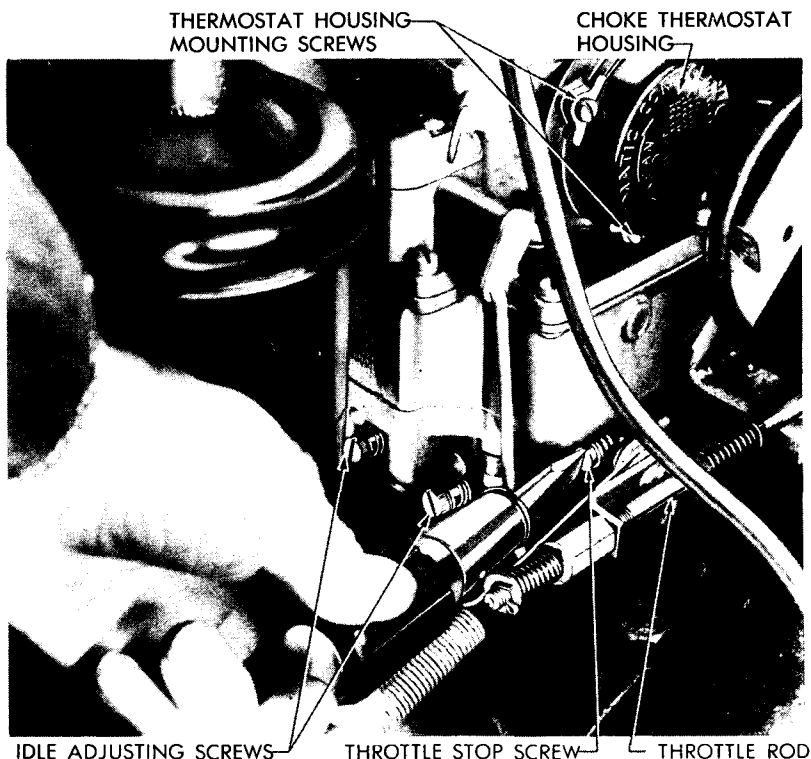


Figure 93. Carburetor adjustments.

AIR INTAKE ELBOW

CRANKCASE AIR CLEANER



CARBURETOR CHOKE SHAFT

CARBURETOR

RA PD 331818

*Figure 94. Testing choke shaft.*

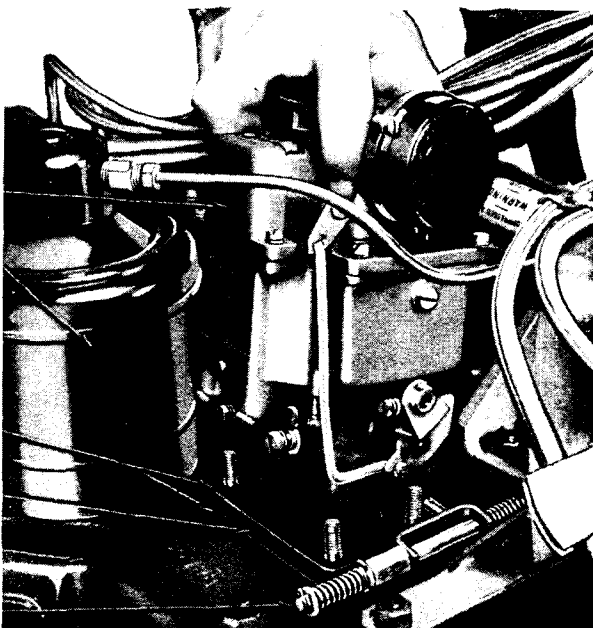
CARBURETOR  
CRANKCASE  
VENTILATOR AIR  
CLEANER

GASKETS

INSULATOR

INTAKE  
MANIFOLD

THROTTLE ROD



*Figure 95. Removing or installing carburetor.*

positions. Loosen hose clamp at carburetor auxiliary fuel filter and slide hose off connection. Loosen hose clamp at crankcase breather tube at rear of carburetor and slide hose off nipple. Unhook throttle pull-back spring from throttle rod and slide rod out of throttle shaft. Remove four nuts holding carburetor to intake manifold and remove carburetor and upper gasket (fig. 95). Leave insulator and lower gasket on manifold.

*d. INSTALLATION.* Install a new gasket over insulator on intake manifold. Place carburetor over mounting studs on intake manifold and install four retaining nuts. Slide rubber gasoline hose over connection on carburetor auxiliary filter and tighten hose clamp. Connect crankcase breather hose to fitting at rear of carburetor and tighten hose clamp. Connect choke thermostate air line to carburetor and to exhaust manifold by screwing nut on pipe into fitting on carburetor and manifold. Tighten securely. Slide air intake elbow over top of carburetor and tighten hose clamps securely. Connect air lines to carburetor intake elbow and tighten securely. Slide trunnion on throttle rod through throttle shaft lever, hook pull-back spring to hole in trunnion, and connect spring to bracket on manifold front clamp bolt.

*e. THROTTLE LINKAGE ADJUSTMENT.* (1) Run engines until they are thoroughly warm (at least 165° F.) so that choke valves are wide open. Adjust throttle stop screw so that each engine speed is from 450 to 475 revolutions per minute as noted on the tachometer, with the transmission selector lever in **DRIVE** position and parking brakes set. Insert a ¼-inch drill rod through cross shaft relay lever and cross shaft mounting bracket on left engine to set throttles in zero position (fig. 96). If pin does not line up with holes in lever and mounting bracket, turn throttle adjusting nut on end of throttle rod assembly until pin slides through both holes freely. Remove the pin. Pull out hand throttle until engines are turning over approximately 1,000 revolutions per minute. Speed of engines should not vary more than 50 revolutions per minute at idling speed, or 100 revolutions per minute at 1,000 revolutions per minute. Equalize speed of engines by turning throttle rod assembly adjusting nut at end of throttle rod. With engines turned off, pull up on engine cross shaft to rear relay rod as far as possible to set throttle in wide-open position, and be sure that throttle valves are wide open.

(2) Working in driving compartment, push down on accelerator pedal (with engines not running) until throttles are in wide-open position, and measure distance between accelerator pedal and front hull plate. This distance should be one-eighth inch with throttle linkage in full-open position. If clearance is incorrect, disconnect rod from pedal cross shaft lever to front throttle relay and turn clevis until ⅛-inch clearance is secured. Reconnect rod and tighten lock nut.

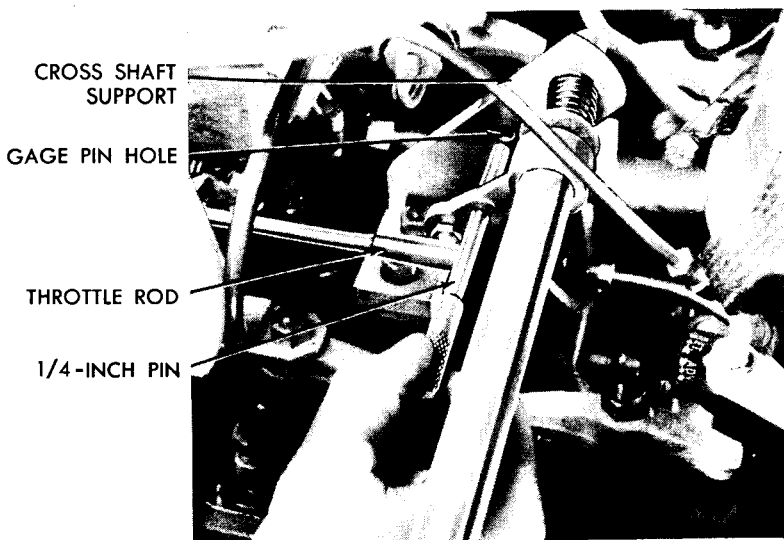
Engage auxiliary accelerator and adjust pedal in same manner. Adjust hand throttle by turning adjusting nuts on end of hand-throttle cable until nuts are one-eighth inch from trunnion with throttle linkage in closed position. Be sure of freedom between trunnion and hand-throttle-cable extension. Bend mounting bracket, if necessary, to line up cable with trunnion.

*f. SERVICING AUXILIARY FUEL FILTER.* Loosen bail nut and remove bowl from filter. Do not try to remove gasket as it may be cemented in place. Wash filter element with dry-cleaning solvent.

**Caution:** Do not damage the disks. Do not scrape or scrub or use compressed air. Do not disassemble the filter element. If element cannot be cleaned satisfactorily, replace entire element assembly. Wash fuel bowl before reinstalling. Install fuel bowl on filter, making sure that gasket is in place and tighten bail nut. Nut should be tightened finger-tight. If bail nut is overtightened, the gasket may be cut by the fuel bowl or the bail stretched to the point where a good seal between the bowl and the filter body cannot be obtained. In the event the bail has been stretched, it may be kinked slightly to allow the bail nut to contact the bowl. Check for leak when engines are running.

## 111. Fuel Pumps

*a. DESCRIPTION.* An electric fuel pump is mounted at the bottom of each fuel tank in a screened cage at the lower end of the fuel-pump support assembly. This pump consists of a small electric motor which

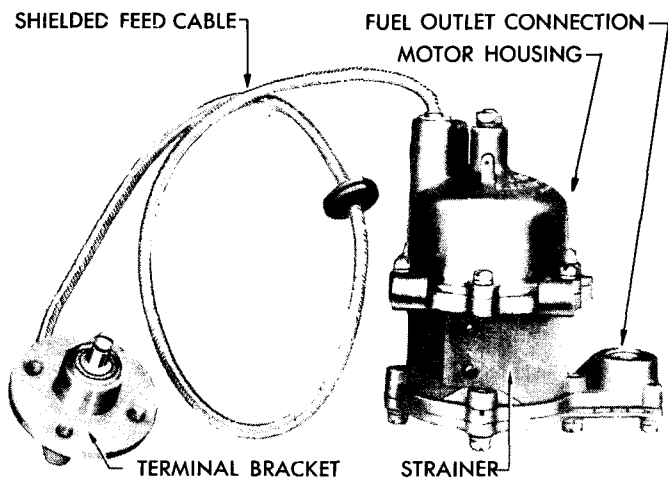


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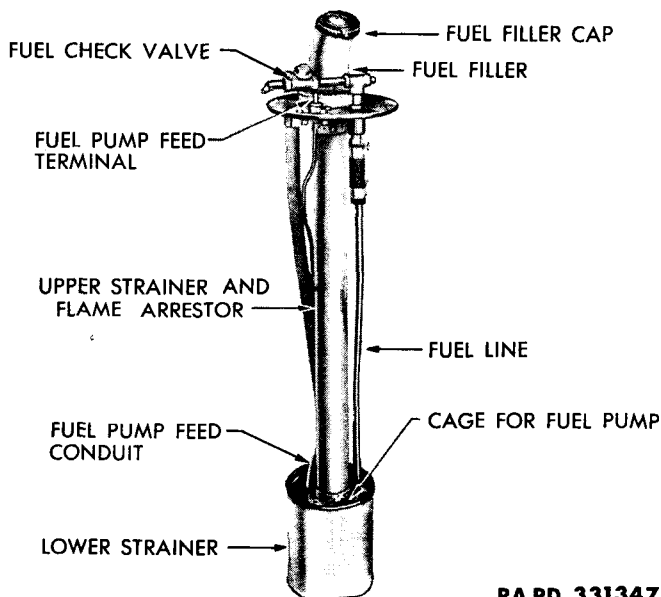
*Figure 96. Inserting gage pin for throttle cross shaft.*

rotates a centrifugal-type impeller (fig. 97). The entire pump assembly operates submerged in gasoline.

b. **REMOVAL.** Fuel pumps normally require no attention in service. To replace an inoperative pump, remove the support assembly by first turning master switches to the "OFF" position, and then removing fuel-tank-cover plate by removing the attaching screws and lifting off plate (fig. 99). Remove screw which holds pump feed wire to terminal and tape end of wire. Loosen hose clamp at fuel-outlet



*Figure 97. Electric fuel pump.*



**RA PD 331347**

*Figure 98. Fuel-pump-support assembly.*



elbow and slide hose off nipple. Remove 12 attaching screws and remove complete support assembly (fig. 98). Remove four screws holding cover to bottom of cage and remove cover. Loosen hose clamp at fuel pump discharge port nipple. Remove four cotter pins and mounting cushions, and lower pump in mounting cage. Loosen set screw at electrical-feed cable at top of fuel pump and unscrew feed-cable connection. Remove fuel pump from cage.

*c. INSTALLATION.* Connect electrical-feed cable to top of fuel pump and lock in place with set screw. Raise pump in mounting cage and, at the same time, insert discharge-port nipple into hose. Install mounting cushions and four new cotter pins, and tighten hose clamp securely. If cage-cover seal has been removed, install seal against upper cage flange. Place cover on bottom of cage and install four attaching screws. Position a new gasket on fuel tank and slide support assembly into fuel tank and into retainer in bottom of tank. Install 12 attaching screws, mounting ground strap under one screw and tightening all screws securely. Connect fuel line hose connection to nipple and tighten hose clamp (fig. 99). Remove tape from end of feed wire and install on terminal. Place rubber guard over terminal. Position fuel tank cover over opening and install attaching screws.

## **112. Fuel Tanks and Lines**

*a. DESCRIPTION.* Two fuel tanks, of approximately 55 gallons each, are carried in narrow, deep compartments on each side of the engine compartment. Each tank contains a cover and pump support assembly on which are mounted all of the parts normally requiring service.

*b. DRAINING.* A drain-hole cover is secured to the hull floor directly under each fuel tank (fig. 26). To drain the tank, remove the four cap screws holding the plate in position, and remove the drain plug at the bottom of the tank.

*c. REMOVAL.* Unlatch battery compartment covers and lift off covers. Remove covers over fuel tanks by removing the attaching screws and lifting off covers. Turn master battery switch to **OFF** position. Disconnect fuel pump feed wire at terminal and tape wire. Disconnect terminals at battery. Remove two battery hold-down nuts (fig. 80). Remove hold-down and lift out battery. Remove battery box retaining screws and lift out battery box. Remove screw holding ground strap to top of fuel pump support assembly. Remove screws holding conduit clamps to fuel tank cover angles and lay conduit to one side. Loosen hose clamp at fuel pump assembly outlet and slide hose off connection. Remove two screws holding shut-off valve assembly to side of hull; disconnect fuel line at shut-off valve by loosening hose clamp and slide hose off connection. Lay conduit and shut-

off valve assembly to one side. Remove screws holding compartment cover angles to hull and remove angles. Remove screws holding flat spring spacers to insulating pad on inner wall of compartment and pull out spring spacers. Attach a rope sling through lifting handles on fuel tank and remove tank from compartment.

*d. INSTALLATION.* Lower fuel tank into compartment. Install three flat spring spacers between tank and inner compartment, sliding into groove provided. Install retaining screws. Position fuel tank compartment angles around opening, making sure that the seals are in proper position, and install angle attaching screws. Install battery box. Lower battery in battery box and install hold-downs. Connect terminals to battery (fig. 80). Place shut-off valve assembly against inner compartment wall and install two attaching screws. Reconnect fuel line to shut-off valve and nipple on fuel pump support assembly and tighten hose clamps. Install three screws and clamps holding conduit to inner fuel compartment angle. Connect ground strap to top of fuel pump support assembly, and reconnect feed wire to terminal. Install rubber guard over terminal. Position fuel tank cover and battery cover over openings and install attaching screws.

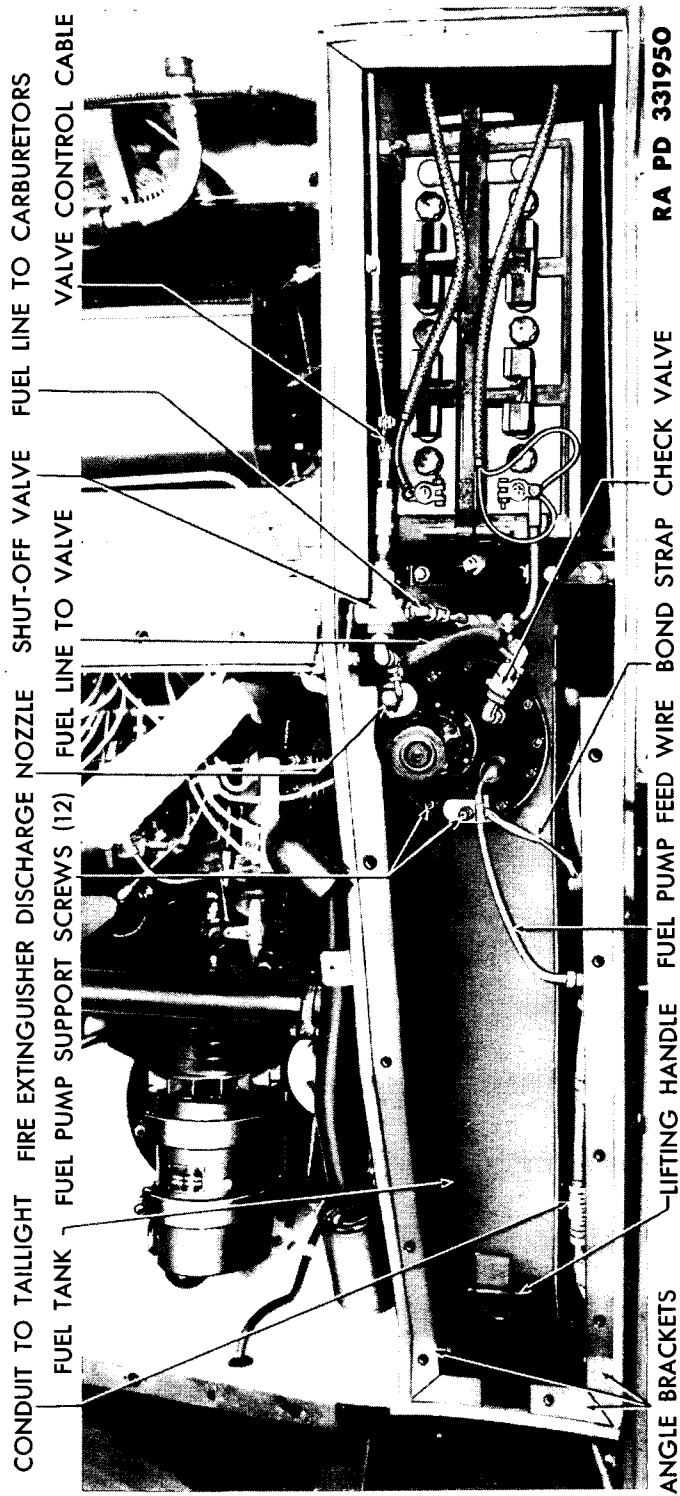
*e. REPLACEMENT OF LINES.* (1) The main fuel line extends from one fuel tank to the other, and is carried across the support at the front of the engine compartment (fig. 91). This line contains two **T** connections from which a rubber line extends to an auxiliary filter at the carburetor float chambers. The fuel lines are connected to the **T**'s for the carburetor by short hose connections. These connections are of a neoprene composition, and should not be replaced with ordinary rubber hose.

(2) When removing the fuel line, be sure fuel control levers are in the OFF position. Remove fuel tank cover. Disconnect the fuel line at the shut-off valve at the side of the engine compartment by loosening hose clamps and sliding hose off pipe. Disconnect fuel hose at each carburetor auxiliary filter by loosening hose clamp and sliding hose off nipple. Remove four bolts and clamps holding main line to the support bar and lift the fuel line as an assembly out of vehicle.

(3) To reinstall the fuel line, position the assembly against the support bar and install the four bolts and clamps holding main line to bar. Slide fuel hose over nipple at carburetor auxiliary filter and tighten hose clamp. Reconnect fuel line at shut-off valve and tighten hose clamp. Start both engines and run for a sufficient length of time to check all connections for leaks. Install fuel tank covers. Close engine compartment.

### **113. Exhaust Pipes and Mufflers**

*a. GENERAL.* The exhaust system, consisting of the exhaust manifolds, manifold connections, mufflers, and exhaust pipes can be re-



*Figure 99. Fuel tank with cover plate removed.*

moved with the engines in the vehicle. The removal of the exhaust manifolds and manifold connection is covered in paragraph 65.

b. **REMOVAL.** (1) *Open engine compartment door.* Turn door latches and raise doors.

(2) *Remove engine compartment doors and covers.* Refer to paragraph 67.

(3) *Remove muffler assembly.* Remove bolt and lock washer attaching exhaust pipe extension to exhaust pipe outlet elbow. Remove bolt at rear of exhaust pipe extension on extension shield and slide extension towards rear enough to clear outlet elbow (fig. 60). Remove screw and nut attaching muffler outlet pipe support bracket to muffler inlet pipe assembly. Loosen two nuts at outlet pipe clamp at muffler, work outlet pipe free of muffler, and remove from vehicle. Remove two bolts and nuts holding muffler and inlet pipe assembly to exhaust manifold connection pipe (fig. 61), and remove muffler. Discard used gasket.

(4) *Remove exhaust manifolds.* Refer to paragraph 65.

c. **INSTALLATION.** (1) *Install exhaust manifolds.* Refer to paragraph 65.

(2) *Install muffler.* Lower muffler and inlet pipe assembly into position in vehicle. Place a new gasket between the exhaust connection flange and muffler inlet assembly. Install two bolts and nuts holding muffler inlet assembly to exhaust connection flange. Insert end of muffler and outlet pipe into muffler and position clamp around pipe and muffler. Install screw and nut which attach outlet pipe support bracket to muffler inlet pipe assembly.

*Note.* Do not tighten bolts at muffler clamp or at support bracket until exhaust pipe extension is temporarily installed for alignment of rear support bolt.

Tighten bolts at muffler and support and remove exhaust pipe extension.

(3) *Install engine compartment covers.* Refer to paragraph 68b (18).

(4) *Install exhaust pipe extension.* Slide exhaust pipe extension through extension shield and into muffler outlet elbow (fig. 60). Install attaching screw at outlet elbow. Install exhaust pipe extension rear support bolt at extension shield and tighten securely (fig. 60).

(5) *Install engine compartment doors.* Refer to paragraph 68b (20).

## **Section XXVI. COOLING SYSTEM**

### **114. Description and Data**

a. **DESCRIPTION.** (1) The vehicle is equipped with two identical, but completely independent cooling systems, one for each engine and transmission (fig. 100). Each system contains the following major

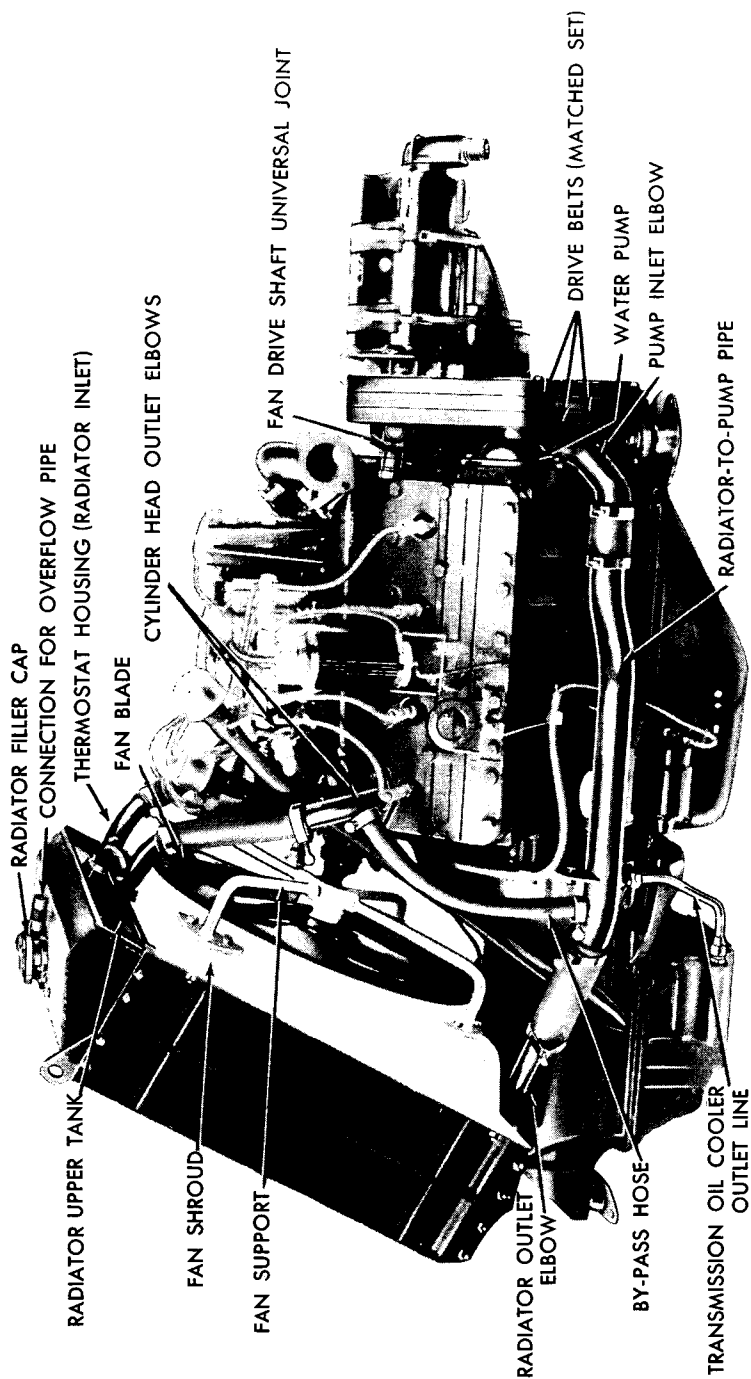


Figure 100. Cooling system.

units: radiator, water pump, thermostat and necessary connections, engine fan and fan drive, and oil cooler for the hydramatic transmission.

(2) The coolant is drawn from the radiator by the water pump and forced into the engine water jackets. After circulating through both cylinder blocks and cylinder heads, the heated coolant is forced up through hose connections to the upper tank of the radiator. A blocking-type bimetal thermostat with double poppet valves, located in the radiator inlet housing, permits free flow when the coolant is hot. However, it causes cold fluid to recirculate through a bypass hose back to the water pump and through the engine until the engine reaches an efficient operating temperature.

(3) Cooling fluid is also pumped through an external pipe to an oil cooler located in the transmission oil pan, where it cools the transmission oil and is returned to the water pump.

(4) The capacity of each cooling system is 40 quarts.

(5) The engine fan is carried in a mounting spider attached to the fan shroud at rear of radiator. The fan is driven by a drive shaft mounted on ball bearings under the intake manifold, and through a universal joint and yoke connected to the generator pulley.

*b. TABULATED DATA. (1) Fan.*

Blades, angle-----	32°.
Blades, diameter-----	21 inch.
Blades, number of-----	4.
Drive-----	Belts, drive shaft and universal joints.
Drive ratio-----	1.1 to 1
Make-----	Hayes.

*(2) Radiator.*

Core area (each)-----	540.5 square inches.
Type-----	Tube-and-fin.
Make-----	Harrison.

*(3) Thermostat.*

Location-----	Radiator inlet housing.
Opening temperature-----	140° to 146° F.
Type-----	Bimetal.
Make-----	Dole valve.

*(4) Water pump.*

Drive-----	Triple belt.
Lubrication-----	Fitting.
Packings-----	Spring-loaded, chevron-type.
Type-----	Centrifugal.
Location-----	Right front of engine block.

## 115. Maintenance

a. **ADDING COOLANT.** (1) *Vent filler cap before removing.* Whenever removing the filler cap from a hot system, always vent the radiator long enough to allow all pressure in the system to escape; otherwise, there is a possibility of serious personal injury from steam and hot water. To vent the radiator, turn the cap to the left (counter-clockwise) until the first stop is reached (fig. 101). Leave the cap in this position at least one-half minute, or long enough to vent the system thoroughly. Then press down on the cap to clear the stop, and then turn it further to the left to remove.

(2) *Install cap securely.* After bringing the fluid to the proper level (2 inches below filler neck), reinstall the radiator cap, and be sure to turn it as far as possible by hand so that the entire cooling system will be sealed while operating. If this is not done, there may be excessive loss of coolant while operating under severe service.

*Note.* Make sure radiator cap gasket is in good condition and in place before installing cap.

b. **DRAINING AND FILLING.** (1) *Drain system.* Each cooling system is drained at one point only, a plug marked "WATER," in the bottom of the transmission oil pan (fig. 27). Remove radiator cap to vent system for rapid and complete draining.

(2) *Install coolant.* Add water or antifreeze as required, pouring at moderate speeds to avoid undue spillage. It may be necessary to run the engine for a few minutes before the thermostat opens and permits complete filling of the system. Be sure to perform this operation if the system seems full before 40 quarts have been added.

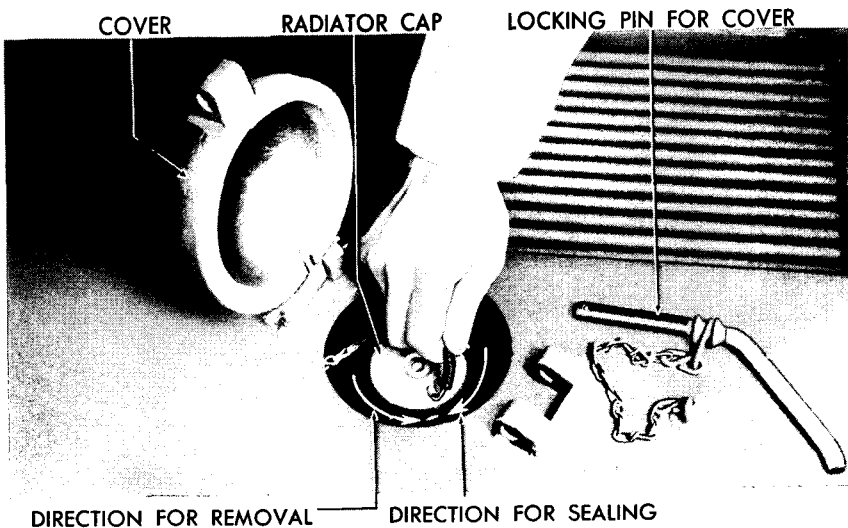


Figure 101. Removing radiator cap.

c. **CLEANING.** (1) *Flushing.* Open the petcocks which shut off the coolant from the heaters or other accessories, if used, to allow for complete circulation during the cleaning, flushing, and draining. Run the engine, with the air inlet covered if necessary, until the temperature is within operating range. Stop the engine, remove the radiator cap, and drain the system by opening the drain plug in the transmission oil pan (fig. 27).

(2) Allow the engine to cool. Close the drain plug, pour water slowly into the radiator until the system is approximately half full, then run the engine at idling speed. Add cleaning compound in the proportion of one container of cleaner to every 4 gallons of cooling system capacity. Then complete filling the system with water.

**Caution:** Never mix the water and the cleaning compound before putting them into the system. Do not spill the solution on skin, clothing, or painted portions of the vehicle.

(3) Install radiator cap and run engine at fast idling speed, covering air inlet if necessary, until coolant reaches a temperature above 180° F. but not over 200° F. Do not drive the vehicle.

(4) Stop the engine after it has run for 30 minutes at 180° F. but not over 200° F. Then remove drain plug and radiator cap and drain system completely.

(5) For information on back-flushing of engines, refer to TM 9-2858.

d. **NEUTRALIZING.** (1) Allow engine to cool. Install drain plug, pour water slowly into the radiator until the system is approximately half full (20 quarts), then run engine at idling speed. Add neutralizer compound in the proportion of one container of neutralizer to every 4 gallons of cooling system capacity. Each cleaning compound container contains a separate portion of neutralizer. Then fill system with water.

(2) With air inlet covered, let engine idle for at least 5 minutes at normal operating temperature. Then stop engine.

(3) Drain system completely by removing drain plug and radiator cap.

e. **FLUSHING.** (1) Allow engine to cool. Install drain plug. Pour water slowly into radiator until system is approximately half full, then run engine at idling speed and fill system completely.

(2) Run engine, keeping air inlet covered if necessary, until coolant is heated to normal operating temperature.

(3) Drain system by removing drain plug and radiator cap. Repeat flushing operation until drain water is clear.

(4) Again allow engine to cool and clean all sediment from radiator cap valves and overflow pipe. Blow insects and dirt from radiator core air passages with compressed air, blowing from the rear. Use water if necessary to soften obstructions.



*f. LEAKS.* After completing the flushing operation, make certain that engine has been allowed to cool again. Install drain plug. Pour water slowly into radiator until system is approximately half full, then run engine at idling speed and fill system to 2 inches below bottom of filler neck. Stop engine. Examine entire cooling system for leaks. This is important because the cleaning solution uncovers leaks which exist but are plugged with rust or scale. Leaks that cannot be corrected by the using arms should be reported immediately to ordnance maintenance personnel. After leaks have been remedied perform *g* below.

*g. COOLANT SERVICE.* (1) When servicing the vehicle for summer, fill the system nearly full with clean water. Add corrosion-inhibitor compound in the proportion of one container of inhibitor to each 4 gallons of cooling system capacity. Then complete filling the system with water.

(2) When servicing for winter, fill the system about one-third full of clean water. Add sufficient antifreeze compound (ethylene-glycol type) for protection against the lowest anticipated temperature. Refer to paragraph 23. Add water until system is nearly full, then run engine until normal operating temperature is reached. Then add sufficient water to fill system to 2 inches below bottom of filler neck.

## **116. Hoses and Connections**

*a. REMOVAL.* Drain cooling system (par. 115*b*). Loosen screws in hose clamps and slide hose off ends of radiator, cylinder head and water pump elbows, and bypass fittings.

*b. INSTALLATION.* The hoses are installed without gasket paste or sealer. Install clamps on hoses, slide in place on connection elbows and fittings, and tighten clamp screws securely.

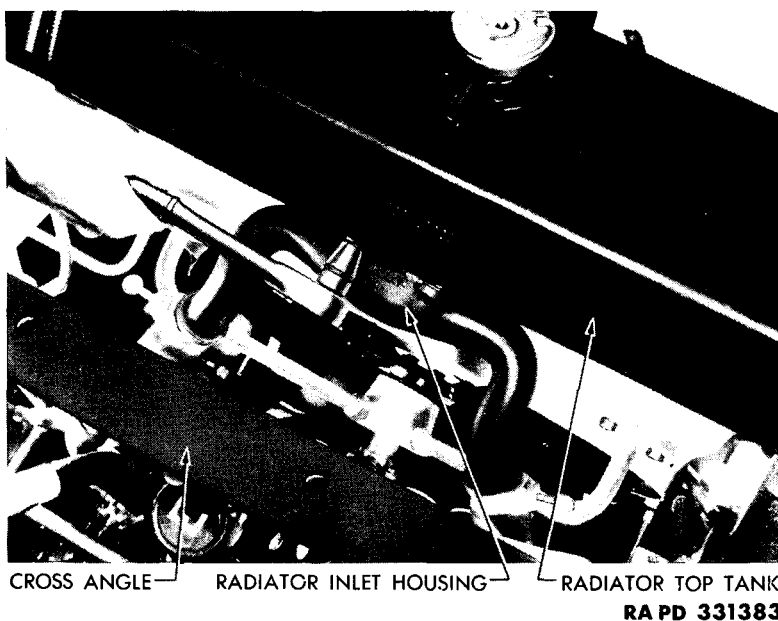
## **117. Radiator Thermostat**

*a. REMOVAL.* Drain approximately 2 gallons of fluid from cooling system and reinstall drain plug. Open engine compartment door. Loosen hose clamps and disconnect the two hoses at radiator inlet housing on top tank. Remove four cap screws and washers holding inlet housing to radiator, and remove housing. Remove thermostat and discard gasket (fig. 102).

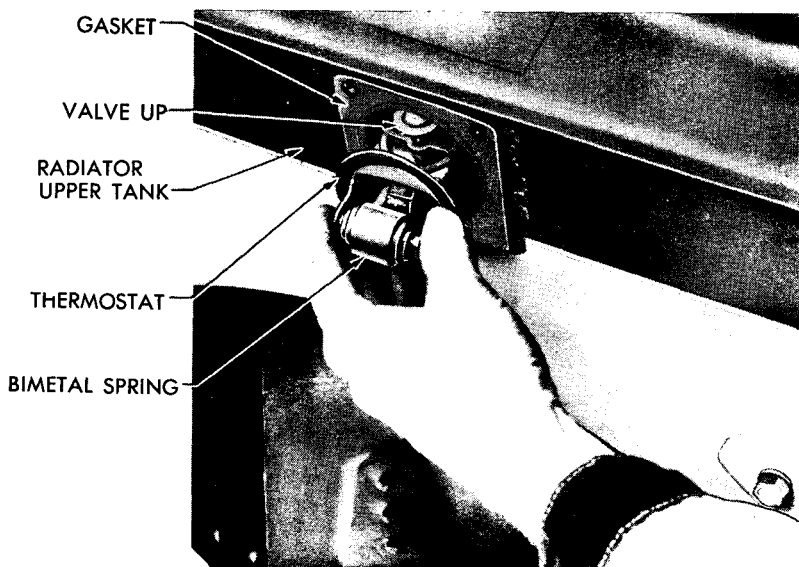
*b. INSPECTION.* Check thermostat by placing it with bimetal coil down on a brick in a pan of water also containing a thermometer.

**Caution:** Do not place either the thermostat or the thermometer on bottom of pan because of uneven concentration of heat at that point when pan is heated over a burner.

Heat water until thermostat valve begins to open. The temperature at which this occurs depends on the heat range which the thermostat is designed for. See tabulated data, paragraph 114. The oper-

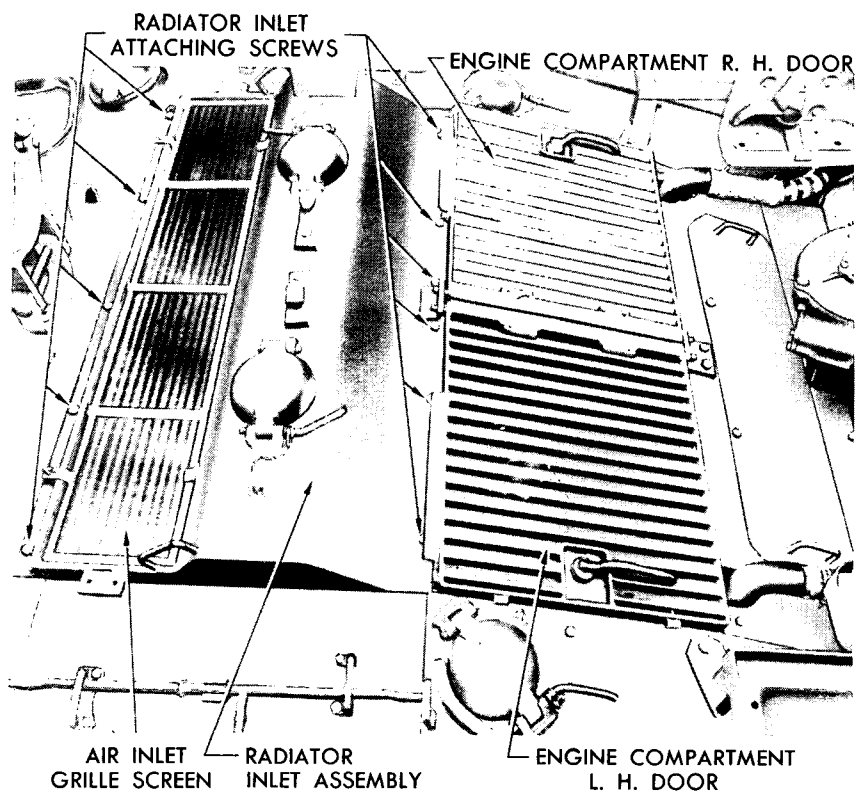


*Figure 102. Radiator thermostat housing.*

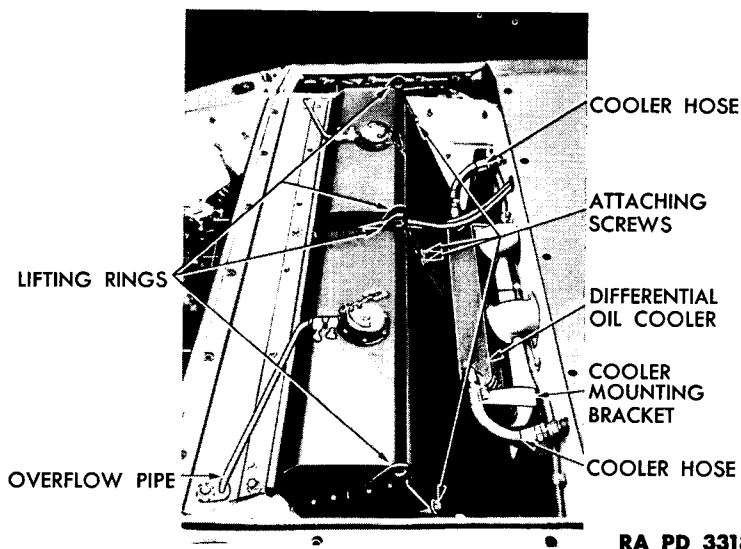


*Figure 103. Installing radiator thermostat.*

ating temperature is stamped on the housing flange of most thermostats. If the thermostat does not open, or does not open at a temperature close to the markings found on the thermostat flange, it should be replaced. If the thermostat does not open and close completely and function freely, or is badly rusted, it should also be replaced.

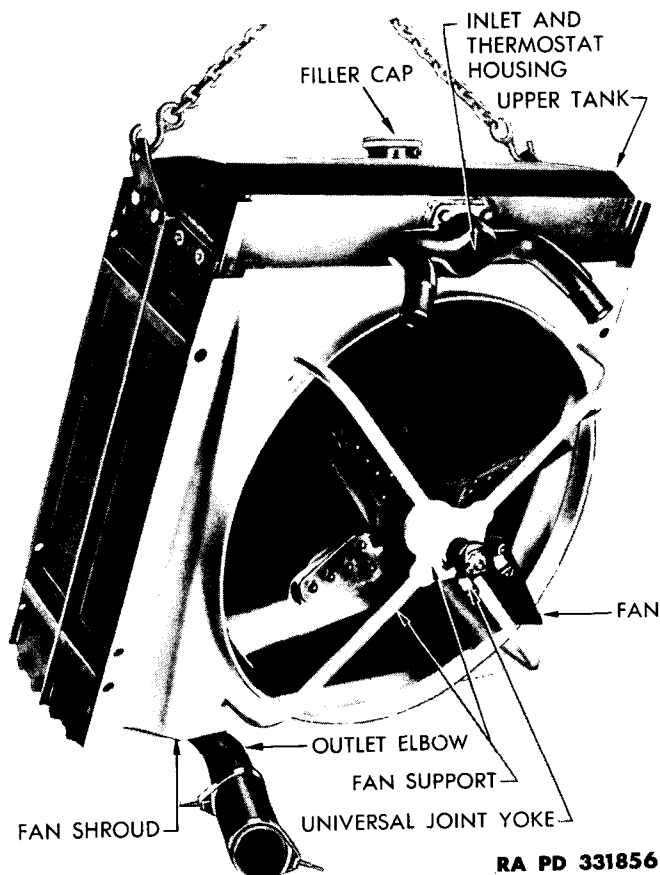


*Figure 104. Radiator inlet mountings.*



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*Figure 105. Radiator and oil cooler mountings.*



*Figure 106. Removing radiator.*

*c. INSTALLATION.* Place a new housing gasket on radiator tank, and position thermostat on gasket with valve extending into radiator tank with axis of valve horizontal (fig. 103). Position housing, and install four mounting screws and washers. Using a torque wrench, tighten cap screws to 18 foot-pounds. Reconnect hose to housing and tighten hose clamps. Fill cooling system and close engine compartment door.

## **118. Radiator and Fan**

*a. REMOVAL.* (1) *Drain cooling system.* Refer to paragraph 115*b*.

(2) *Remove radiator air inlet and engine compartment doors.* Remove two bolts attaching angle plate at rear of engine compartment doors and remove angle plate and doors. Remove five screws holding radiator air inlet assembly to hull roof, and six screws that hold inlet to engine compartment cross angle (fig. 104). Hook sling to inlet assembly, attach hoist to sling, and lift radiator inlet assembly off vehicle.

(3) *Remove radiator.* Disconnect radiator overflow pipes at hose connection at filler neck and under metal seal at engine compartment sides, and remove pipes (fig. 105). Remove five screws that hold metal seal to radiator cross angle and remove seal. Loosen hose clamps on radiator inlet housing at top of radiator and outlet pipe at bottom of radiator, and pull hose off connections. Remove four cap screws holding fan shaft universal joint bearing trunnions on fan shaft yoke. Slide slip joint back to clear fan shaft yoke. Remove two long bolts that hold upper part of radiator to center and side supports. Back out one long bolt holding lower part of radiator to side support.

*Note.* This bolt cannot be removed completely until radiator has been lifted out.

Working on rear side of radiator, remove short bolt that holds radiator to support at center. Hook sling (41-S-3832-82) to lifting rings on top of radiator; connect hoist to sling and lift radiator, shroud and fan assembly out of vehicle (fig. 106). Tilt radiator forward to clear cross angle with fan shaft yoke. Remove other radiator in same manner. Remove eight bolts and washers attaching fan spider to fan shroud and remove fan. Remove four bolts, nuts, and washers attaching fan shroud to radiator and remove shroud.

*b. INSTALLATION.* (1) *Install radiator.* Place fan shroud on radiator and install four attaching bolts, nuts, and washers. Place fan assembly on fan shroud and install eight bolts and washers attaching fan spider to shroud. Connect sling (41-S-3832-82) to radiator lifting rings, attach hoist to sling, slide long lower outer bolt in position, and lower radiator in position in engine compartment. Tilt top of radiator toward rear of vehicle to clear cross angle with fan shaft (fig. 106). Install one long bolt through upper part of radiator and into tapping nut on center support. Screw long lower outer bolt into side support. Working at rear of radiator, install short bolt through center support and into tapping nut on radiator. Reconnect hose connections at radiator inlet housing at top of radiator and outlet housing at bottom of radiator, and tighten hose clamps. Line up fan shaft yoke with universal joint bearing trunnions and install four cap screws and lock plates. Tighten cap screw to a torque tightness of 16 to 20 foot-pounds and lock in place by bending lock plate ears over flat of cap screw. Position metal seal on radiator cross angle and radiator, and install five mounting screws with washers (fig. 105). Place radiator overflow pipe on top of radiator, connect short hose at filled neck and hose under metal seal at engine compartment side to pipe, and tighten hose clamps. Install overflow pipe clip screw.

(2) *Install radiator air inlet and engine compartment doors.* Hook sling on air inlet assembly, attach hoist to sling, and lift inlet assembly into position on vehicle. Install bolts through radiator inlet front flange and into hull roof. Do not tighten bolts. Line up six holes

in rear of radiator inlet with bolt holes in radiator cross angle, and install six bolts. Position two engine compartment doors over opening and install angle plate and two bolts. Tighten bolts after lining up engine compartment door and radiator inlet on hull.

(3) *Refill cooling system.* Refer to paragraph 115.

## 119. Water Pump

*a. REMOVAL.* Drain cooling system (par. 115*b*). Reinstall drain plug. Open engine compartment doors. Remove four bolts attaching generator access plate at rear of engine compartment (fig. 59) and remove plate. Loosen locking nut holding generator cradle in position, and lower generator to lowest position. Slip belts off water pump pulley by hand. Loosen hose clamp that holds hose on pump body inlet. Remove five screws and washers that hold water pump body to cylinder block, and remove pump and discard gasket (fig. 107).

*b. INSTALLATION.* Place new gasket on water pump, and position pump on cylinder block with pulley under generator and water pump belts. Install five pump mounting screws and lock washers, and draw up evenly (fig. 107). Reconnect pump inlet hose and tighten hose clamps. Reinstall belts on water pump pulley, prying in place by hand only. Using large screwdriver or small utility bar between generator and generator cradle, pry up on generator and adjust belts until there is from  $\frac{5}{8}$ - to  $\frac{3}{4}$ -inch deflection in belts measured midway

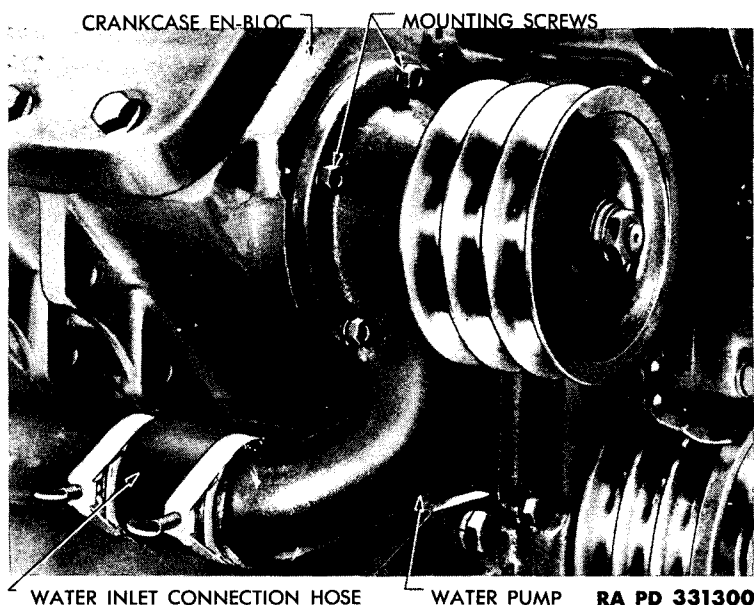
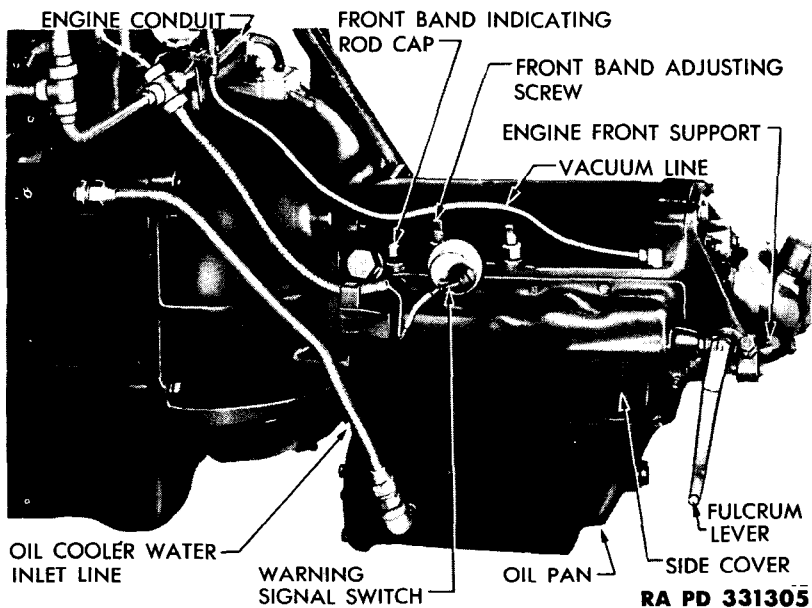
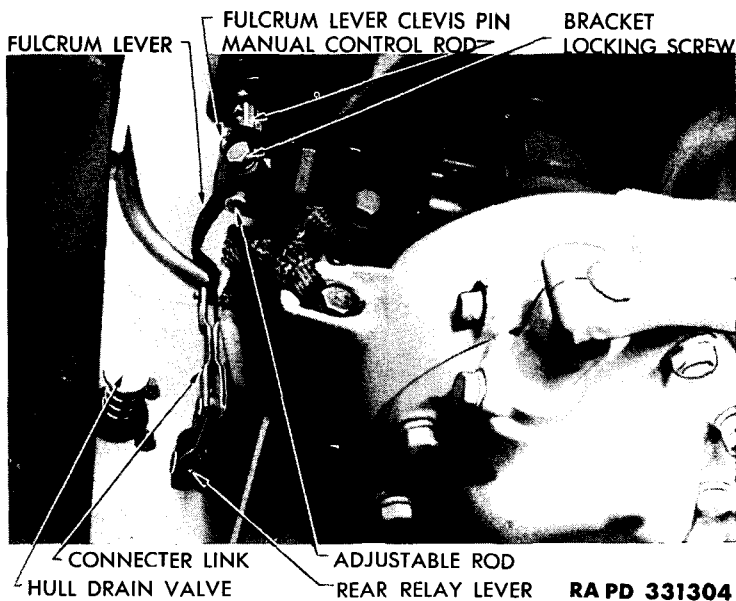


Figure 107. Water pump mounting.

between generator and water pump pulleys (fig. 50). Hold generator in this position and tighten generator cradle locking nut. Replace access plate at rear of engine compartment. Close engine compartment doors. Refill cooling system.



*Figure 108. Hydramatic transmission.*



*Figure 109. Adjusting transmission control linkage.*

## Section XXVII. HYDRAMATIC TRANSMISSIONS

### 120. Description and Data

*a. DESCRIPTION.* The hydramatic transmission (fig. 108) consists of a fluid coupling and an automatic hydraulic-operated transmission having four speeds forward. No reverse gearing is incorporated in the transmissions as this is provided in the transfer unit. Slippage in the fluid coupling at engine idling speeds eliminates the need for a clutch. Gear changes are made automatically by hydraulic pressure, and are governed by the speed of the vehicle and the extent to which the driver depresses the accelerator. In this section, the fluid coupling end of the transmission will be referred to as the "front" end, and the output shaft end as the "rear" end.

*b. DATA.*

Clutch type.....	Fluid coupling.
Number of speeds.....	4.
First speed gear ratio.....	3.92 to 1.
Second speed gear ratio.....	2.53 to 1.
Third speed gear ratio.....	1.55 to 1.
Fourth speed gear ratio.....	1 to 1.
Type gearing.....	Planetary.

### 121. Manual Control Linkage Adjustment

*a. GENERAL.* The transmission manual control linkage from the neutral pedal in the driving compartment to the cross shaft under the bulkhead is set at assembly of the vehicle, and normally requires no further adjustment. If engines are replaced, or it becomes necessary to synchronize transmission control linkage, adjustment should be made at the fulcrum lever mounting bracket on the transmission rear bearing support (fig. 109) as outlined below.

*b. ADJUSTMENT PROCEDURE.* Place transmission selector lever in "DRIVE" slot of quadrant (fig. 9). Open door in bulkhead extension cover over transfer unit. Working through opening, loosen clamp screw on fulcrum lever adjusting rod (fig. 109). Move fulcrum lever and attached levers to the middle detent position. Holding adjusting rod in position, tighten clamp screw. Adjust other transmission linkage in same manner.

*c. CHECK ADJUSTMENT OF BOTH TRANSMISSIONS.* Set brakes. Run both engines at same time with transfer unit in HIGH and transmission selector lever in NEUTRAL. Set hand throttle to run engines at 1,000 revolutions per minute, and move selector lever slowly toward DRIVE. By watching tachometers, note position of lever when speed of one engine drops. Rear edge of selector lever should be approximately one-eighth inch in front of front edge of slot in quadrant when



engine speed drops. Continue moving lever until speed of other engine drops. This should be within  $\frac{1}{8}$ -inch additional lever travel. If difference is greater, readjust fulcrum lever of newly installed transmission.

## 122. Band Adjustment

a. GENERAL. The transmission front band is provided with an adjustment-indicating rod (fig. 110) and can be adjusted in the vehicle. The rear band is provided with an automatic band adjuster and does not incorporate an indicating rod. If tests indicate that the rear band requires adjusting, notify ordnance personnel.

b. ADJUSTMENT PROCEDURE. Remove 18 mounting screws and remove hull rear floor cover under engine and transmission to be checked. Set vehicle brakes, place transmission selector lever in **NEUTRAL** and start engine.

*Note.* Transmission should, if possible, be at normal operating temperature before making band adjustments.

Working through the engine compartment floor opening, remove transmission band indicating rod cap (fig. 108). Run engine for a few minutes at idling speed; then move transmission selector lever to **DRIVE** position and set hand throttle so that engine is running at approximately 1,000 revolutions per minute. Hold a straightedge or

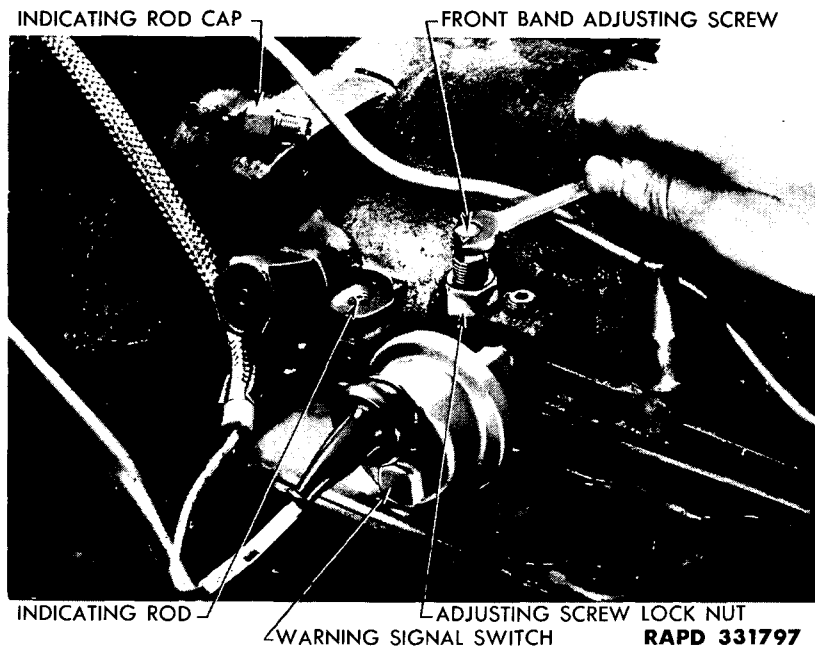


Figure 110. Front band adjustment.

scale across front band indicating rod boss, and check to see if indicating rod end is flush with rod boss on transmission case. Band is correctly adjusted when indicating rod end is flush with rod boss on transmission case (fig. 110). If band adjustment is incorrect, move lever back to NEUTRAL, loosen band adjusting screw lock nut and turn front band adjusting screw to estimated correct adjustment, move lever again to DRIVE, and recheck. Repeat until indicating rod end is flush with rod boss. Idle the engine. Lock band adjusting screw and recheck adjustment. Install indicating rod cap, being sure seal is in place.

**Caution:** Run one engine only, and do not pull the engine against the fluid coupling for more than 1 minute at a time, and allow at least 3 minutes for the oil to cool before repeating.

### 123. Transmission Replacement

a. **AUTHORITY.** Replacement of this major assembly with a new or rebuilt unit is normally a field maintenance operation, but may be performed in an emergency by organizational maintenance units, provided authority for performing this replacement is obtained from the appropriate commander. Tools needed for the operation which are not carried in organizational maintenance units may be obtained from a higher maintenance unit.

b. **REMOVAL.** (1) *Remove engine.* Remove engine and transmission assembly (par. 67).

(2) *Remove lower flywheel housing.* Remove six screws that hold lower flywheel housing to upper housing; remove housing and discard gasket.

(3) *Remove starter motor.* Disconnect solenoid at terminal on solenoid relay. Remove two mounting bolts holding starter to flywheel housing and remove starter.

(4) *Remove lines and leads.* Disconnect right and left oil cooler lines at transmission oil pan fittings (fig. 108); loosen upper connections at crankcase and water pump inlet pipe; and move lines out of the way. Loosen hose clamp on hose connecting transmission and engine oil filler tubes at transmission filler side. Remove screw that holds transmission filler tube lower mounting to transmission case. Remove nut holding filler tube upper mounting bracket to rear manifold clamp stud, and remove tube. Disconnect vacuum line at fitting on intake manifold and elbow on transmission case (fig. 108). Remove flywheel housing mounting screw holding vacuum line clips, and remove line. Disconnect warning signal switch wire at switch on transmission, and pull conduit out of clip on transmission side cover.

(5) *Drain transmission.* Install socket wrench on engine crankshaft pulley mounting screw and turn crankshaft until flywheel cover drain plug is at the bottom. Remove drain plug in flywheel cover and

in transmission oil pan (fig. 27) and drain transmission. Reinstall drain plugs.

(6) *Remove transmission.* Install lifting eye (41-B-1586-300) in top of transmission case. Connect hoist to eye and take up weight of transmission. Remove 30 screws that hold flywheel cover to flywheel.

*Note.* Rotate crankshaft with socket wrench on engine crankshaft pulley mounting screw.

Remove remaining six screws that hold flywheel housing to crankcase and pull engine conduit out of the way. Pull transmission back to slide flywheel housing off dowels in crankcase, and mainshaft pilot out of bearing in end of crankshaft, and remove transmission.

*c. INSTALLATION.* (1) *Install transmission.* Position new flywheel cover gasket on flywheel.

**Caution:** Do not use gasket sealer of any kind.

Install lifting eye (41-B-1586-300) in transmission case, attach hoist to eye, and lift transmission into position behind engine crankcase. Push transmission toward engine, entering dowels in crankcase in holes in flywheel housing and mainshaft pilot in bearing in end of crankshaft. Install six flywheel housing mounting screws, placing clips for engine conduit and vacuum pipe clip under upper screws. Tighten screws to 45 to 50 foot-pounds, using torque wrench and tightening lower screws first.

(2) *Install flywheel cover.* Pull flywheel cover toward flywheel and line up dowels in flywheel with holes in cover. Hold cover in position and install one mounting screw adjacent to dowels. Turn flywheel 180° (using socket wrench on crankshaft pulley mounting screw) and install another screw. Tighten these two screws to 12 to 15 foot-pounds, making sure that cover seats properly on flywheel and flywheel dowels. Install two screws approximately 90° to dowels and tighten to 12 to 15 foot-pounds. Install remaining 26 screws and tighten all screws to 25 to 30 foot-pounds, using a torque wrench. Then tighten all screws to 40 to 45 foot-pounds, proceeding in rotation around the flywheel. Disconnect hoist and remove lifting eye.

(3) *Install starter motor.* Lift starter into position on flywheel housing, and install two mounting screws through housing and into starter mounting flange. Connect solenoid wire to terminal on solenoid relay.

(4) *Connect lines and leads.* Connect transmission warning signal switch wire to switch, and push conduit into clip on transmission side cover. Connect vacuum line to intake manifold and to elbow on transmission case. Position filler pipe in transmission case and push upper side outlet into hose connection on engine oil filter tube and upper mounting bracket over engine manifold rear stud. Install screw through lower filler tube mounting bracket and into transmission case. Install nut holding upper tube bracket to manifold stud, and tighten

hose clamp on transmission to engine filler tube hose. Connect oil cooler lines to fittings on transmission oil pan and tighten upper and lower connections.

(5) *Install lower flywheel housing.* Install new gasket on lower flywheel housing and lift into position on upper flywheel housing and install six mounting screws.

(6) *Install engine.* Install engine and transmission assembly in vehicle (par. 68).

(7) *Refill transmission.* Install 10 quarts of engine oil. Start engine and run for approximately 5 minutes to fill fluid coupling (fig. 28) ; then add an additional 5 quarts to bring oil up to FULL mark on gage. Make certain the engine is stopped before adding the last 5 quarts.

## 124. Torus Member Replacement

a. **AUTHORITY.** Replacement of this major assembly with a new or rebuilt unit is normally a third echelon operation, but may be performed in an emergency by second echelon, provided authority for performing this replacement is obtained from the appropriate commander. Tools needed for the operation which are not carried in second echelon may be obtained from a higher echelon of maintenance.

b. **REMOVAL.** (1) *Remove engine.* Remove engine and transmission assembly from vehicle (par. 67).

(2) *Remove transmission.* Remove transmission assembly from engine (par. 123a).

(3) *Remove torus members.* Straighten mainshaft nut lock, and remove nut and lock holding driven torus member on shaft. Pull

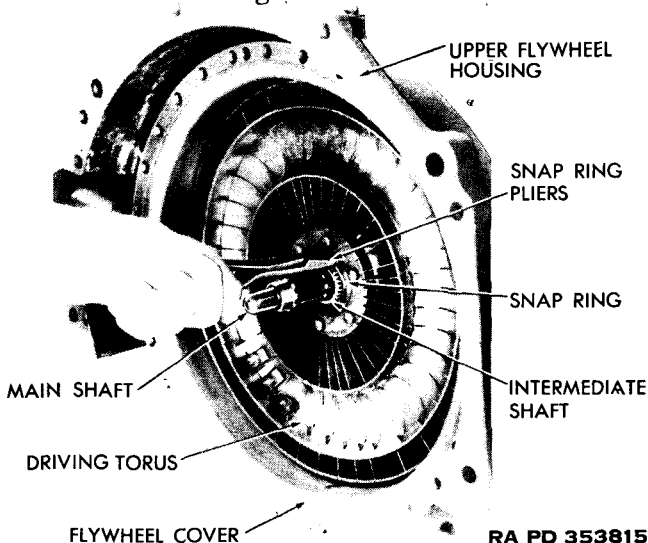


Figure 111. Removing driving torus snap ring.

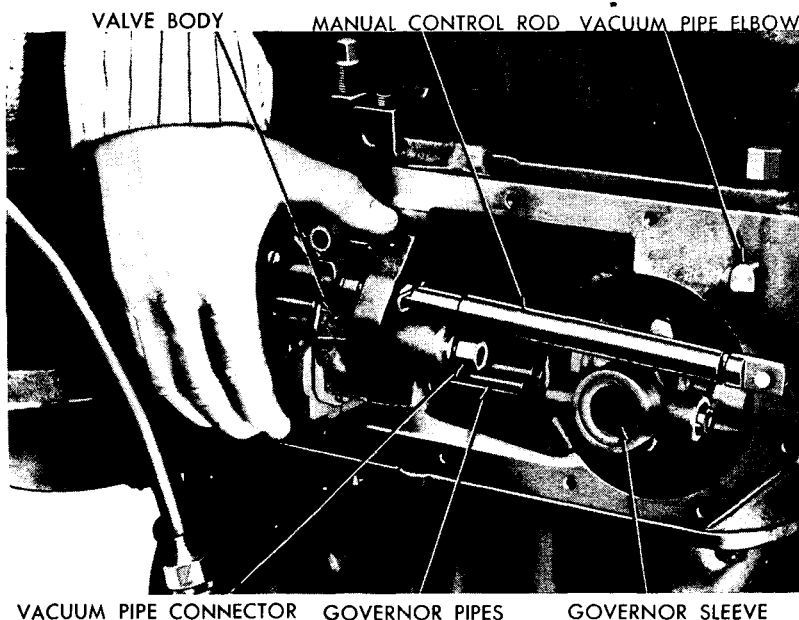


Figure 112. Removing transmission valve body.

driven torus member off mainshaft. Remove snap ring holding driving torus on intermediate shaft, using snap ring pliers (41-P-1992-85) (fig. 111). Pull out on driving torus and remove from intermediate shaft.

c. **INSTALLATION.** (1) *Install torus members.* Push driving torus on splines of intermediate shaft and install snap ring (fig. 111), using snap ring pliers (41-P-1992-85). Push driven torus on transmission mainshaft splines, and see that oil pressure regulator on inner hub slides over end of intermediate shaft. Install driven torus retaining nut and new lock on mainshaft and bend lock back over nut.

(2) *Install transmission.* Install transmission assembly on engine (par. 123b).

(3) *Install engine.* Install engine and transmission assembly in vehicles (par. 68).

## 125. Valve Body

a. **REMOVAL.** (1) *Remove center hull floor cover.* Remove screws from hull floor cover under transmission.

**Caution:** Support rear end of cover while removing last screws to prevent cover from dropping down and causing injury.

Front of cover is held up by hooks on cover. Slide cover toward rear of vehicle and lower to ground.

(2) *Remove side cover.* Working through the floor opening, remove hairpin lock and clevis pin that hold manual control fulcrum lever to adjustable mounting bracket on rear bearing support (fig. 109). Then lower lever out of the way.

*Note.* Do not disconnect fulcrum lever at lower end.

Remove the two cap screws that hold the lever mounting bracket to the transmission, and remove the bracket by pulling it straight out to clear the two locating dowel pins. Pull warning signal switch conduit out of retaining clip on side cover. Disconnect lead wire on warning signal switch and remove signal switch. Pull rubber boot off end of manual control rod, and back rod bearing nut out of cover. Remove 11 screws that hold side cover to transmission case (fig. 108), move cover out at engine end to clear valve body, and then pull toward front of vehicle to clear manual control rod end and remove cover.

**Caution:** When removing side cover, be very careful to prevent any dirt from falling into transmission through case openings.

(3) *Remove valve body.* Disconnect control valve vacuum pipe at valve body and elbow on transmission case and remove pipe. Remove four control valve body mounting screws and pull valve body assembly toward engine to move oil tubes out of governor sleeve, and remove assembly (fig. 112).

*Note.* The only organizational maintenance operation authorized on the valve body is removal and installation.

An improperly operating valve body should be reported to ordnance personnel.

*b. INSTALLATION.* (1) *Install valve body.* Make sure valve body mounting surface on transmission case and valve body are free of nicks and burs, and thoroughly clean. See that three oil pipes are in position in valve body (fig. 112), and place valve body in position on transmission case, entering the three oil pipes into governor sleeve. Hold in position and install four mounting screws, tightening evenly to 6 to 8 foot-pounds, using a torque wrench. Position vacuum pipe on valve body and transmission case fittings and connect.

(2) *Install side cover.* Be sure governor plug is in place in governor sleeve. Position a new side cover gasket on transmission case.

**Caution:** Do not use gasket sealer of any kind.

Place side cover in position by holding valve body end of cover away from transmission, and sliding opposite end of cover over manual control rod. Then move cover toward engine block and over valve body. Install 11 cover mounting screws and copper washers. Slide control rod bushing nut over rod, tighten into side cover, and install rubber boot over rod, seeing that outer end of grommet seats in groove in rod. Reinstall warning signal switch. Push conduit into clip on side cover and connect lead wire to switch terminal. Reinstall fulcrum

lever mounting bracket to transmission, making sure holes in bracket line up with locating dowels on transmission. Install two attaching screws and tighten securely.

(3) *Adjust manual control linkage.* Connect and adjust linkage at fulcrum lever mounting bracket (par. 122b).

(4) *Install full floor cover.* Coat edges of floor plate with joint and thread compound (cement, type II) and place gasket on plate. Raise front edge of plate until hooks on plate rest on hull floor. Raise rear end of plate, and line up screw holes with drift punch. Install floor plate retaining screws.

## Section XXVIII. PROPELLER SHAFTS AND SUPPORT BEARINGS

### 126. Description and Data

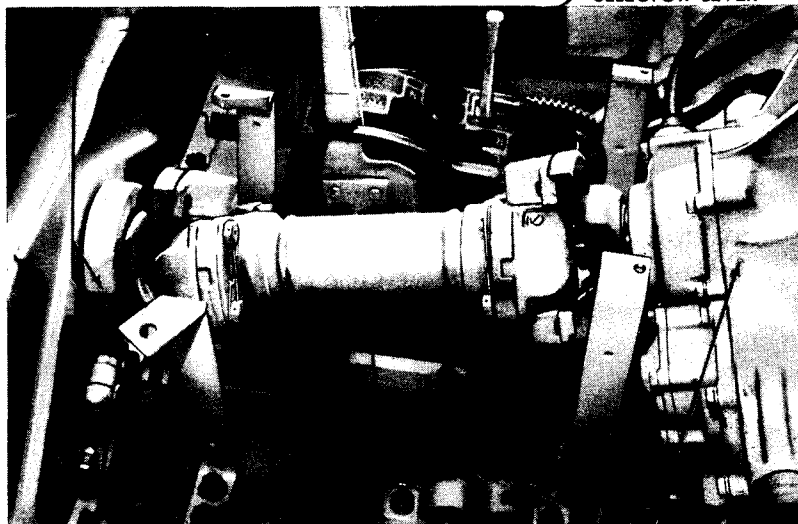
a. **CONSTRUCTION.** There are three propeller shafts used in this vehicle. The main propeller shaft extends from the transfer unit forward to the controlled differential. Two final drive propeller shafts extend from the controlled differential, one on each side, to the final drives. The main propeller shaft is of welded steel tube construction. The final drive shafts are made of two forged yokes welded together.

b. **MAIN PROPELLER SHAFT.** The main propeller shaft is provided with a yoke for the universal joints welded to each end. The rear universal joint yoke is splined to provide a sliding joint with the

BULKHEAD EXTENSION FELT  
SEAL AND RETAINERS

TRANSFER UNIT  
SHIFT LEVER

TRANSMISSION  
SELECTOR LEVER



TRANSFER UNIT SHIFTER MAIN PROPELLER SHAFT CONTROLLED DIFFERENTIAL  
SHAFT EXTENSION (SHIELDS REMOVED)

RA PD 331821

*Figure 113. Main propeller shaft.*

transfer unit mainshaft, and the front yoke is splined to fit on the differential pinion shaft.

c. **FINAL DRIVE PROPELLER SHAFTS.** The final drive propeller shaft consists of two forged yokes welded together. The yokes on each side of the controlled differential are splined to the output shafts, and are a slip fit to compensate for movement of the unit and to provide clearance when removing the shafts. The yokes on the final drive input shafts are also splined, but are held on the shafts by a large nut and cotter pin.

d. **TUNNEL AND GUARD.** The main propeller shaft is mounted in a tunnel formed by metal shields on each side, supported by brackets attached to the hull floor and sealed at the rear by a baffle bolted to the hull floor and bulkhead extension. The top of the propeller shaft tunnel is covered by the periscope stowage box. The final drive propeller shafts are protected by sheet metal shields which fit around the shafts and universal joints, and are bolted together at mounting brackets on the controlled differential and final drive cases. Leg guards are mounted on the final drive housings. All guards are easily removable for service work.

e. **TRANSMISSION—TRANSFER UNIT.** The connection between each transmission and the transfer unit is made by two universal joints and a coupling block. The transmission output shaft carries the rearmost yoke, and the foremost yoke is a sliding spline fit into the short transfer unit input shaft.

f. **DATA.**

Propeller shafts, number used----	3
Propeller shafts, type-----	Welded tube and welded forgings.
Universal joints, number used----	10.
Universal joints, type-----	Needle bearing.
Universal joints, make-----	Mechanic's.

## 127. Main Propeller Shaft

a. **REMOVAL.** (1) *Remove periscope stowage box.* Remove four cap screws holding periscope stowage box to support bracket and lift box from its position.

(2) *Remove left propeller shaft guard.* Remove one screw holding this guard in position and lift out guard.

(3) *Disconnect front universal joint.* Remove lock wires and four cap screws holding the front propeller shaft universal joint bearing housings to yoke, pry propeller shaft back to telescope rear yoke on transfer unit shaft, and break joint.

(4) *Remove propeller shaft.* Lift propeller shaft up and pull off from transfer unit shaft. Remove shaft from vehicle through the driver's door. Use care not to damage oil seal surface of sliding yoke.

b. **INSTALLATION.** (1) *Install propeller shafts in vehicle.* Lower



propeller shaft into the vehicle through driver's door opening. Slide yoke on rear end of shaft through seal and over splines of transfer unit output shaft.

(2) *Connect front universal joint.* Raise front end of shaft and telescope shaft on transfer unit output shaft until sufficient room is provided to connect front universal joint. Line up bearing housings with yoke on controlled differential pinion shaft. Install four cap screws, tighten to 85- to 95-foot-pounds torque, and install locking wires.

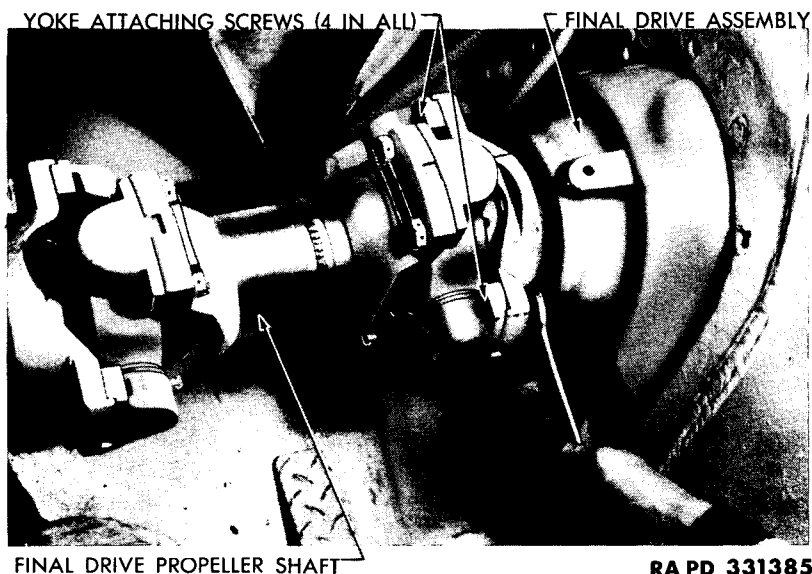
(3) *Install propeller shaft guard.* Install left propeller shaft guard and fasten in place with one screw.

(4) *Install periscope stowage box.* Place periscope and spare head stowage box in position on support brackets and fasten securely with four cap screws.

## 128. Final Drive Propeller Shafts

a. **REMOVAL.** (1) *Remove shield and guard.* Remove four cap screws holding propeller shaft shield to mounting brackets on controlled differential and final drive housing and remove shield.

(2) *Disconnect outer universal joint.* Remove locking wire and four screws (fig. 114), holding universal joint bearing housing to yoke on final drive input shaft. Slide propeller shaft toward differential as far as it will go and disconnect universal joint.



RA PD 331385

Figure 114. Removing final drive propeller shaft.

(3) *Remove propeller shaft.* Slide propeller shaft toward side of vehicle to pull yoke off differential output shaft, and remove propeller shaft assembly from vehicle.

b. **INSTALLATION.** (1) *Install propeller shaft.* Lower propeller shaft assembly into vehicle. Lift shaft into position. Engage yoke on differential output shaft spline and push yoke into differential as far as possible. Line up holes in bearing housing with holes in yoke on final drive input shaft, and install four screws holding housings to yoke. Lock wire through the screw heads, together in pairs.

(2) *Install shields.* Position propeller shaft shields around shafts, and install four screws holding shield to brackets on controlled differential and final drive housing.

## Section XXIX. TRANSFER UNIT

### 129. Description and Data

a. **DESCRIPTION.** The transfer unit is mounted on support brackets on the hull floor between and partially ahead of the two transmissions. The transfer unit performs two functions: It combines the power output of the two engines; and it provides two speed ranges forward and one in reverse, all of which are manually selected. Each transfer unit input gear is connected to the input shaft by means of a sliding coupling, which in turn is connected to the input clutch lever on the outside of the case. This arrangement permits disconnecting either one of the engines if an engine is disabled, so that the vehicle can be driven by one engine without the drag of the disabled engine.

b. **DATA.**

Number of speeds forward.....	2.
Number of speeds reverse.....	1.
Gear ratio in <b>LOW</b> .....	2.34 to 1.
Gear ratio in <b>HIGH</b> .....	1.03 to 1.
Gear ratio in <b>REVERSE</b> .....	2.44 to 1.
Type of gears.....	Helical.
Type of shift.....	Manual, synchro-mesh.

### 130. Transfer Unit Shift Lever

a. **DESCRIPTION.** The transfer unit shift lever is mounted in a bracket bolted to the hull floor at the right side of the driver's seat (fig. 115). When the lever is moved to the left and pushed forward, the lower end of the lever engages the reverse arm and lever assembly which is connected by rods to the reverse gear shifter shaft assembly. This slides the reverse gear clutch along the mainshaft, locking the reverse gear to the mainshaft. When the shift lever is moved to the right and pushed forward or backward, the lower end of the shift lever

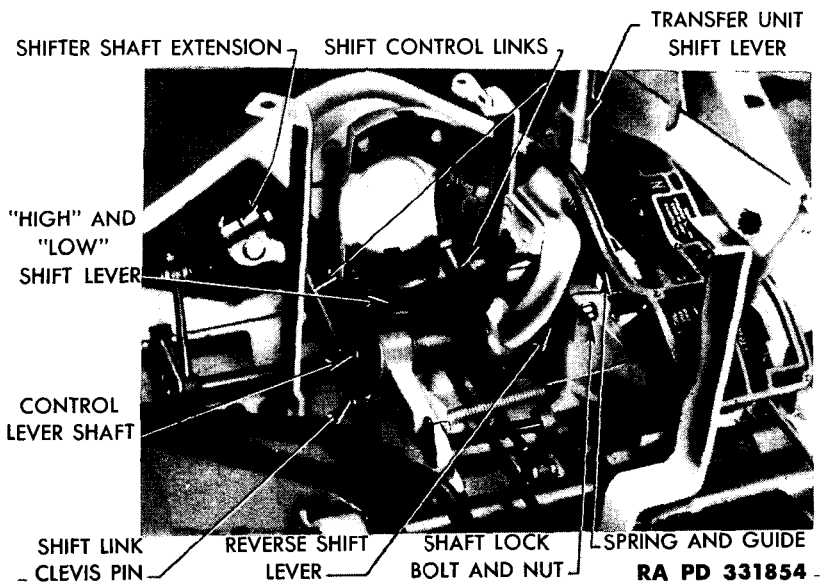


Figure 115. Removing transfer unit shift lever.

engages the arm and lever assembly for the HIGH and LOW shifter shaft. This moves the high and low gear synchronizer clutch along the mainshaft to engage the gear selected by the driver.

**b. REMOVAL.** (1) *Remove periscope box.* Remove four screws holding the box to the four supporting brackets and one screw holding box to bulkhead extension at right side. Push transfer unit shift lever to the REVERSE position and remove box assembly.

(2) *Remove shift lever spring and guide.* Lift up on spring guide to compress spring until guide clears hole in shifter lever cross shaft. Remove spring and guide (fig. 115).

(3) *Remove shift lever shaft clamp bolt.* Remove nut and washer from shift lever clamp bolt and remove bolt.

(4) *Remove shift lever shaft.* Slide shift lever cross shaft out of support bracket toward driver's seat.

**Caution:** Arm and lever assemblies and spacer washers will drop down when shaft is removed.

Note position of parts before removing shaft so they will be reinstalled in the proper sequence.

(5) *Remove shift lever assembly.* Tilt top of lever toward right side of vehicle so that bottom part of lever comes out of side of support bracket. Raise driver's seat to allow room for removing lever.

**c. INSTALLATION.** (1) *Position shift lever in support bracket.* Slide top of shift lever through opening in left side of support bracket so that top of lever comes out through opening on quadrant.

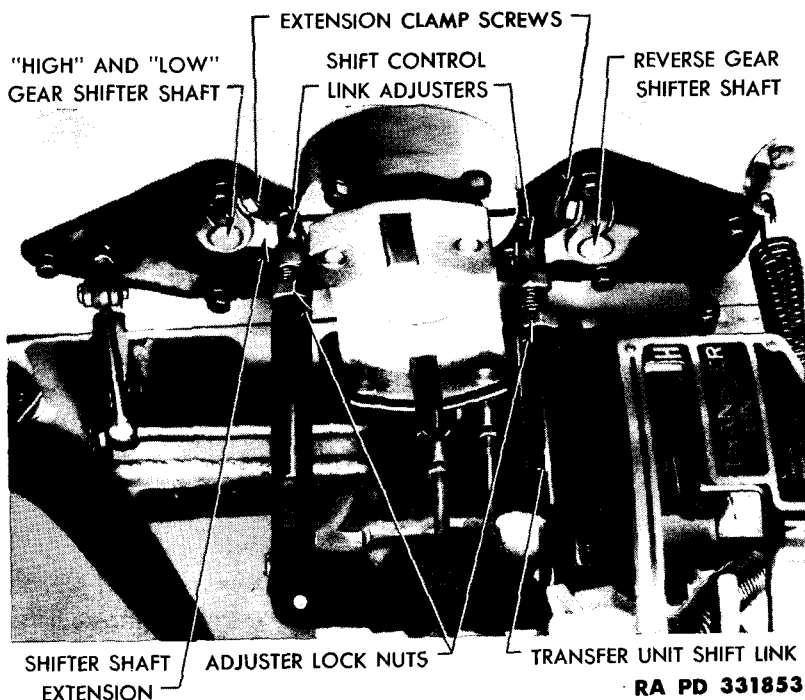


Figure 116. Transfer unit shift linkage.

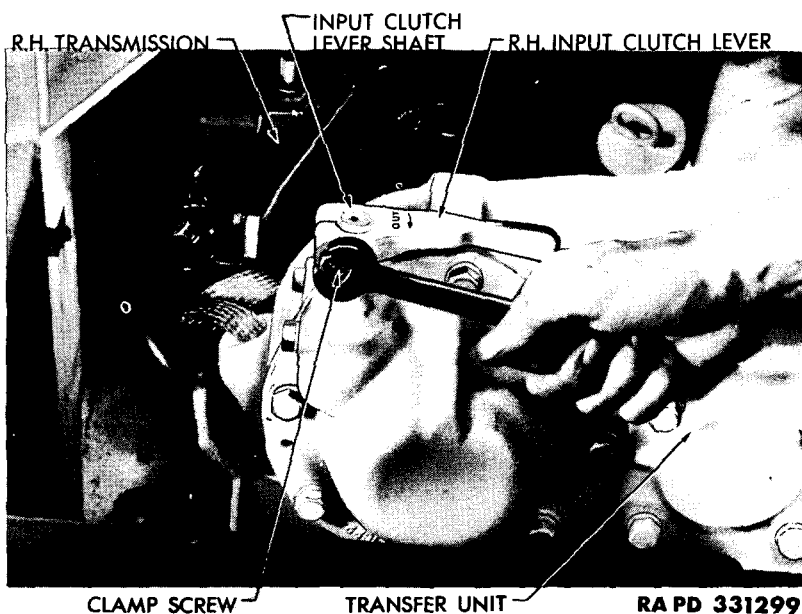


Figure 117. Removing engine input clutch lever.

(2) *Install shift lever cross shaft.* Slide shift lever cross shaft through opening in support bracket.

*Note.* Do not slide shaft all the way in.

Raise **REVERSE** lever and arm assembly, and slide on end of shift lever cross shaft. Next, place one of the spacer washers on shaft and slide shaft through hole in shift lever. Install another spacer washer over shift lever shaft. Raise **HIGH** and **LOW** lever and arm assembly up into position. Slide shaft through this arm also. Install the last spacer washer over the shift lever shaft and slide shaft into other end of support bracket. Line up notch in shaft with hole in bracket and install clamp bolt, nut, and washer.

(3) *Install shift lever spring and guide.* Slide spring and guide onto pin on shift lever. Compress spring on guide so that guide will enter cut-out on shift lever cross shaft.

(4) *Install periscope box.* Place transfer unit shift lever in reverse position to allow room to install box. Slide box into position on the four supporting brackets, and install four screws and washers at supports and one screw at bulkhead extension.

*d. LINKAGE ADJUSTMENT.* (1) *Check adjustment.* Move shift control lever from **HIGH** to **LOW** and from **LOW** to **NEUTRAL** to locate by feel the middle of the neutral detent position. Shift lever should now be in line with gate in quadrant opposite **NEUTRAL**. If it is not, readjust as explained below. When **HIGH-LOW** shift rod is properly adjusted, move shift lever through gate toward driver. Slot in bottom of shift lever should line up with lug on reverse lever and arm assembly. If it does not, readjust reverse shift rod as explained below.

(2) *Remove periscope box.* Remove five screws holding the box to the four supporting brackets and bulkhead. Push transfer unit shift lever to **REVERSE** position and remove box assembly.

(3) *Adjust high-low shift rod.* Loosen lock nut on shift link and turn threaded adjusters (fig. 116) in or out until the shift lever is in the center of the gate in the quadrant when the **HIGH-LOW** shift rod in the **NEUTRAL** detent position. Tighten lock nut on shift link.

(4) *Adjust reverse shift rod.* After **HIGH-LOW** shift rod has been adjusted, adjust **REVERSE** shift rod in same manner so that the slot in the bottom of the shift lever will be in line with the lug on reverse lever and arm assembly. Shift lever should engage **HIGH** and **LOW** lever, and **REVERSE** lever without interference.

(5) *Install periscope box.* Position transfer unit shift lever in **REVERSE**. Slide periscope box into position on four supporting brackets and install attaching screws.

### 131. Engine Input Clutch Lever

a. **DESCRIPTION.** Two input clutch levers, one for each engine, are mounted on vertical shafts on each side of the transfer unit. When a lever is in the rear position, the sliding clutch on the input gear is engaged with the input shaft. When the lever is moved forward, the sliding clutch is disconnected.

b. **REMOVAL.** Open sliding door over top of transfer unit and raise screen. Remove input lever clamp screw and lift off lever (fig. 117).

c. **INSTALLATION.** Place input clutch lever over input clutch shaft and install clamp screw. Close screen and sliding door over transfer unit.

### 132. Transfer Unit Replacement

a. **AUTHORITY.** Replacement of this major assembly with a new or rebuilt unit is normally a field maintenance operation, but may be performed in an emergency by organizational maintenance units, provided authority for performing this replacement is obtained from the appropriate commander. Tools needed for the operation which are not carried in organizational maintenance units may be obtained from a higher maintenance unit.

b. **REMOVAL.** (1) *Remove engines.* Refer to paragraph 67.

(2) *Remove radiators.* Refer to paragraph 118a.

(3) *Remove lower radiator seal.* Remove four screws holding lower radiator seal to engine bulkhead. Lift out seal.

(4) *Remove radiator center support.* Working from driving compartment, remove two screws holding center radiator support to front of engine bulkhead. Remove four screws holding center radiator support to rear radiator support. Lift out support.

(5) *Remove lower fire extinguisher pipes.* Remove four clamps holding pipes to hull floor. Disconnect lower center fire extinguisher pipes at hull side wall connections, and remove screws holding center bracket to hull floor. Remove pipes as an assembly.

(6) *Remove throttle relay rods.* Disconnect and remove intermediate-to-rear throttle relay rod and rear relay as an assembly.

(7) *Remove engine front support cushions.* Remove eight screws holding engine front rubber cushions to engine front support brackets and remove cushions.

(8) *Disconnect shifter shaft extensions.* Remove shifter shaft extension clamp screw that locks extension to shifter shaft (fig. 116). Drive a small wedge or a chisel in slot in extension until extension is free on shaft. Move shifter lever towards **HIGH** to slide extension off high-low shifter shaft and towards **REVERSE** to slide extension off reverse shifter shaft.

(9) *Loosen bulkhead extension shifter shaft seals.* Remove four screws which attach shifter shaft seal to bulkhead extension and pull

seal away from bulkhead enough to clear transfer unit housing at shifter shaft (fig. 113). It is not necessary to disconnect other linkage and remove seal completely.

(10) *Remove propeller shaft rear yoke seal retainers at bulkhead extension.* To provide additional clearance, remove four screws holding seal retainer halves to bulkhead extension and remove retainers. Seal is split and may be removed from yoke if condition indicates necessity.

(11) *Remove transfer unit.* Attach a rope sling around transfer unit as shown in figure 118. Remove the three transfer unit mounting screws. Attach chain hoist to rope sling, and take up weight of transfer unit. Raise transfer unit and slide toward rear of vehicle until propeller shaft universal joint yoke slides off splines of transfer unit output shaft. Raise transfer unit and remove from vehicle.

c. *INSTALLATION.* (1) *Place transfer unit in vehicle.* Attach a rope sling around transfer unit, being sure that it is tied as short as possible (fig. 118). Then connect chain hoist to unit. Lower unit into vehicle. Before lowering unit all the way into position, slide propeller shaft rear yoke onto transfer unit output shaft, and also place the two shifter shaft extensions over the two shifter shafts. Slide transfer unit forward until it rests on the rubber cushion supports. Remove hoist and rope sling.

(2) *Install mounting screws.* Install two front and one rear transfer unit mounting screws and tighten securely.

(3) *Install bulkhead extension shifter shaft seals.* Position seal over shifter shaft and install four screws attaching seal to bulkhead extension (fig. 116).

(4) *Install propeller shaft rear yoke seal and retainers.* Inspect conditions of felt seal at propeller shaft yoke and replace with new seal if found to be badly worn or damaged. Seal is split at an angle to allow removal or replacement without removing propeller shaft yoke. Install seal around propeller shaft yoke and position metal retainers around seal. Install four screws attaching retainers to bulkhead extension.

(5) *Connect shifter shaft extensions.* If extensions were not positioned on shifter shafts while lowering transfer unit to final position, move transfer unit shift lever and at the same time slide shifter shaft extensions onto shifter shafts. Install shifter shaft extension clamp screw at both extensions and tighten clamp screw securely.

(6) *Adjust transfer unit shift linkage.* Refer to paragraph 130d (3).

(7) *Install lower fire extinguisher pipe.* Lower fire extinguisher pipe into position at rear of transfer unit. Install two screws holding center bracket to hull floor, and connect pipes to couplings on hull side wall. Install four clamps and screws.

(8) *Install throttle relay rods.* Install intermediate to rear relay rod and rear relay.

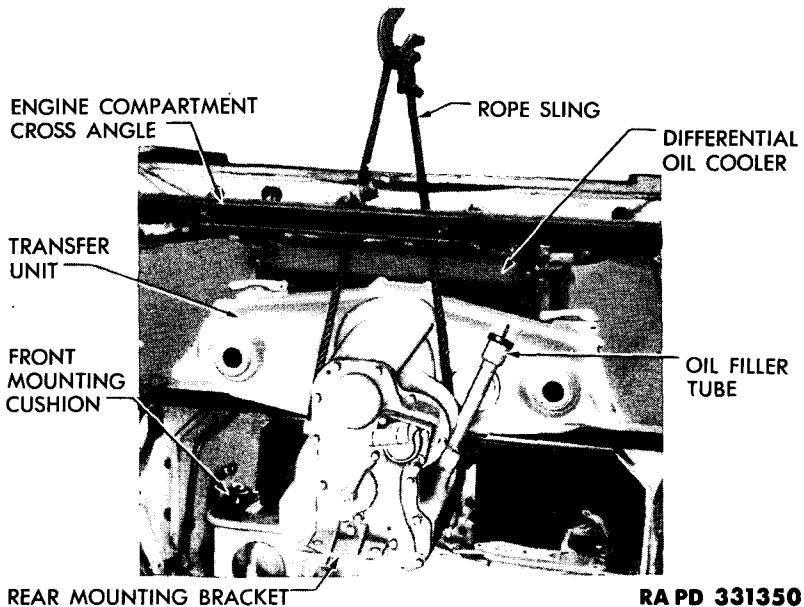
(9) *Install engine front support cushion.* Place the four engine front rubber cushions on the front engine support mounting brackets, and install eight screws and lock washers.

(10) *Install radiator center support.* Slide lower end of center radiator support through slot in bulkhead and install two mounting screws. Position upper end of support against rear radiator support, and install four screws and washers.

(11) *Install lower radiator seal.* Place lower radiator seal in position in opening. Install four screws and washers holding seal to bulkhead.

(12) *Install radiators.* Refer to paragraph 118b.

(13) *Install engines.* Refer to paragraph 68.



*Figure 118. Removing transfer unit.*



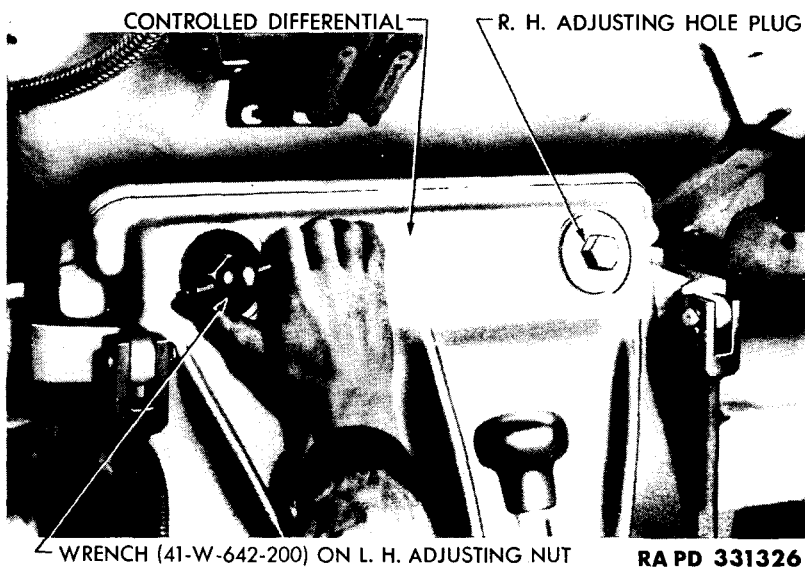


Figure 119. Steering and brake adjustment.

## Section XXX. CONTROLLED DIFFERENTIAL

### 133. Description and Data

*a. DESCRIPTION.* The controlled differential, located at the front of the vehicle, transmits engine power to the final drive units and, in addition, contains the brake drums and bands that permit steering and stopping the vehicle.

*b. DATA.*

Brake rims, number used.....	2.
Size.....	15 by 4 $\frac{1}{4}$ inches.
Brake linings, number per rim.....	3.
Size.....	13 by 4 inches.
Differential gearing, type.....	Spur.
Differential, ratio.....	1.92 to 1 max.
Drive gearing, type.....	Spiral bevel.
Drive gearing, ratio.....	2.62 to 1.

### 134. Steering and Brake-Band Adjustment

*a. GENERAL.* The steering and brake-band adjustment compensates for lining wear. The steering and brake bands should be adjusted whenever required by lining wear, or whenever the controlled differential is removed and installed.

**b. ADJUSTMENT PROCEDURE.** (1) *Remove adjusting hole plugs.* Remove band adjusting hole plug from each side of controlled differential.

(2) *Adjust band.* Insert socket wrench (41-E-642-200) through plug hole and engage adjusting nut (fig. 119). Turn adjusting nut clockwise to tighten band.

*Note.* Brake band adjusting nut has a cylindrical surface on pressure side instead of the usual flat face. It is important that this adjustment be made by one-half turns only, so that this cylindrical surface will always be seated firmly against cross pin when adjustment is completed.

(3) *Check adjustment of steering and brake bands.* Check adjustment by pulling back on steering lever. The adjustment is correct when two conditions prevail: First, brake band must be free when lever is in full forward position. To make second check, place a spring scale at the center of rubber grip on end of steering lever and pull back on lever until a force of 12 to 15 pounds is exerted. In this position, steering lever should be six notches back from forward position on quadrant.

*Note.* On new bands, lever should only move back five notches at a pressure of 12 to 15 pounds.

Repeat check for other brake band. If no spring scale is available, adjustment may be made by observing the following precautions: First, brake band must be free when lever is in full forward (released) position; second, levers should not pull back more than five or six notches under normal steering pressure; and third, levers should not pull back more than three additional notches under full steering or stopping pressure.

*Note.* Brakes adjusted on the "loose side" will not only last longer, but will prevent "glazing" of bands and provide easier steering.

(4) *Install adjusting hole plugs.* Install both band adjusting hole plugs in differential case.

### **135. Steering and Brake Shoes**

**a. REMOVAL.** (1) *Remove differential opening cover.* Remove 18 screws holding differential opening cover to hull front plate. Attach hoist to lifting handles on front cover. Remove cover and gasket and discard gasket.

(2) *Remove differential case cover.* Remove 18 screws that hold differential case cover to differential housing. Lift off cover and discard gasket.

(3) *Remove adjusting nut and link pin.* Back off adjusting nut and remove nut. Slide yoke out of steering brake shaft pin and remove tension spring and washer; then remove brake shaft pin. Remove cotter pin and slide out pin holding link to brake shoe.

(4) *Remove brake shoe assembly.* Grasp brake shoe assembly with both hands and pull out of housing, permitting shoes to rotate around brake drum. Repeat steps (3) and (4) for removal of other brake shoe assembly.

b. **INSTALLATION.** (1) *Install brake shoe assembly.* Install brake shoe assembly by rotating assembly around brake rim.

(2) *Install link to shoe pin.* Line up pinholes in steering brake link and holes in shoes. Slide link to shoe pin into position and install cotter pin.

(3) *Install adjusting nut.* Place steering yoke to shaft pin in position in steering brake shaft. Slide tension spring and washer over yoke and push yoke through steering brake shaft pin. Install adjusting nut on end of yoke. Repeat steps (1) to (3) for other brake shoe assembly.

(4) *Adjust brakes.* Refer to paragraph 134.

(5) *Install differential case cover.* Place a new differential case cover gasket on differential case. Coat gasket with joint and thread compound (cement, type II). Place cover over gasket and install 18 screws and washers holding cover to case. Using a torque wrench, tighten the five  $\frac{1}{2}$ -inch screws to 80 to 85 foot-pounds, and the thirteen  $\frac{7}{16}$ -inch screws to 45 to 50 foot-pounds.

(6) *Install differential opening cover.* Place a new gasket over edge of hull opening, attach hoist to cover, and lower into position on front of hull. Line up screw holes with drift punch and install 18 cover attaching screws. Remove the hoist. Using a torque wrench, tighten screws to 80 to 85 foot-pounds.

## 136. Oil Pump and Screen

a. **REMOVAL.** (1) *Drain oil.* Drain oil by removing small plate under hull floor at front of vehicle and removing differential drain plug. Allow oil to drain and reinstall plug and plate.

(2) *Remove spare periscope box.* Refer to paragraph 127a (1).

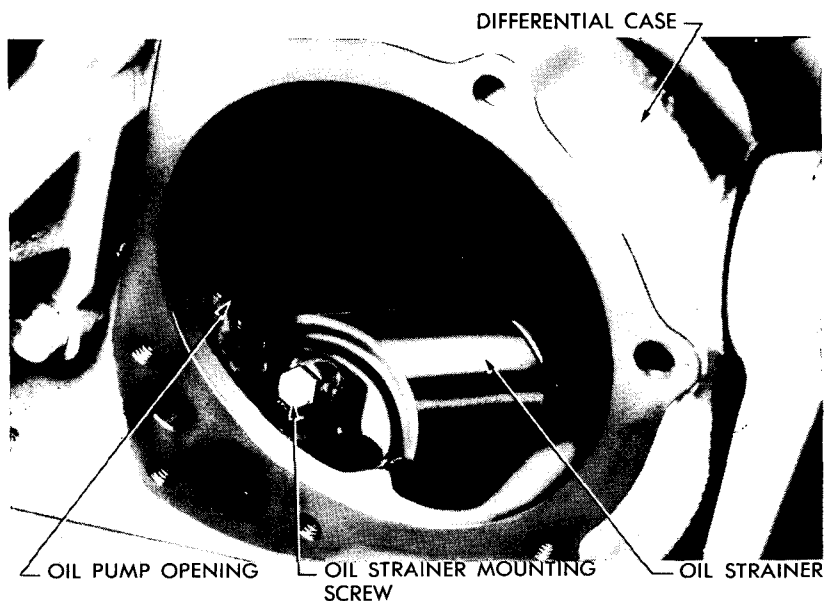
(3) *Remove right propeller shaft guard.* Remove four screws and washers and remove propeller shaft guard.

(4) *Remove propeller shaft guard support.* Remove two screws and washers holding right front propeller shaft guard support to hull floor. Remove the support.

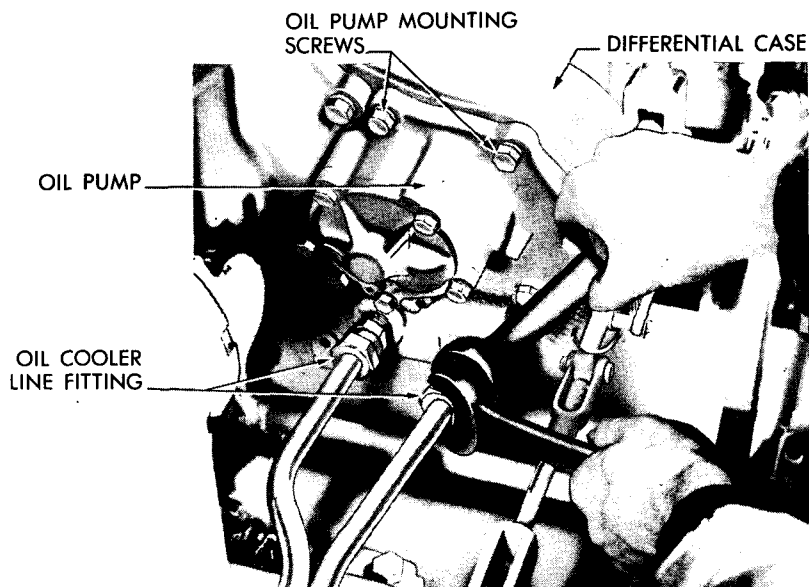
(5) *Remove oil pump.* Remove seven screws and washers holding oil pump to differential case (fig. 120). Then remove pump.

(6) *Remove oil pump strainer.* Remove screw holding oil pump strainer to inside of differential case; slide strainer down toward bottom of case and lift out of oil pump opening (fig. 120).

(7) *Clean screen.* Cut lock wire and remove wing nut from bottom of oil pump strainer assembly and remove cover and strainer screen. Wash all parts in solvent and reassemble.



**CLOSE-UP WITH PUMP REMOVED**



**EXTERIOR VIEW—PUMP AND LINES**

*Figure 120. Removing differential oil lines and strainer.*

*b. INSTALLATION.* (1) *Install oil pump strainer.* Lower oil strainer through oil pump opening and slide pipe on strainer into differential case, making sure rubber gasket is on end of pipe. Install screw and washer holding oil pump strainer to case.

(2) *Install oil pump.* Place a new oil pump gasket on oil pump body and position pump on differential case. Install seven screws and washers holding pump to case.

(3) *Install propeller shaft guard support.* Place propeller shaft guard support over mounting holes on hull floor, and install two screws and washers.

(4) *Install propeller shaft guard.* Position right propeller shaft guard against supports and install four screws and washers.

(5) *Install spare periscope box.* Refer to paragraph 127*b*(4).

(6) *Refill controlled differential.* Refer to paragraph 36.

### 137. Oil Cooler

*a. REMOVAL.* (1) *Elevate the tube.* Elevate the howitzer tube to maximum elevation.

(2) *Remove Air Inlet Assembly.* Remove 11 screws from each end of air inlet assembly and lift out assembly (fig. 104).

(3) *Disconnect cooler hoses.* Disconnect both cooler hoses at bulkhead connection by holding hose stationary with one wrench and turning coupling with another wrench (fig. 121). Plug ends of hoses immediately to prevent oil from running out over radiators.

*Note.* Radiators will clog with dust quickly if oil drips on them.

(4) *Remove cooler.* While a helper supports cooler from top of vehicle, remove four cap screws on fighting compartment side of bulkhead that hold mounting brackets to bulkhead. Lift out cooler.

(5) *Remove cooler hoses.* After cooler has been removed from vehicle, turn on one end to drain oil from unit, and then remove both cooler hoses from ends of cooler by unscrewing hose connections.

*b. INSTALLATION.* (1) *Install cooler hoses.* Coat threaded end of cooler hose fittings with gasket paste, and then install in fitting on end of cooler.

(2) *Install cooler.* Lower cooler assembly into position over front of radiators until holes in cooler brackets line up with holes in bulkhead. While helper holds cooler in this position, install four oil cooler mounting screws from inside vehicle.

(3) *Connect oil cooler hoses.* Connect both oil cooler hoses to connections on bulkhead.

*Note.* Use two wrenches to connect coupling to keep hoses from twisting (fig. 121).

(4) *Install air inlet assembly.* Lower air inlet assembly into position in opening and install 11 attaching screws and washers. Depress howitzer tube.

## 138. Controlled Differential Replacement

a. **AUTHORITY.** Replacement of this major assembly with a new or rebuilt unit is normally a field maintenance operation, but may be performed in an emergency by organizational maintenance unit, provided authority for performing this replacement is obtained from the appropriate commander. Tools needed for the operation which are not carried in organizational maintenance unit may be obtained from a higher maintenance unit.

b. **REMOVAL.** (1) *Remove differential opening cover.*

(2) *Remove periscope and spare head storage box.*

(3) *Disconnect steering brake levers.* Release brakes and push levers forward to the fully released position. Remove cotter pins and clevis pins holding right and left steering and braking control rods to lower end of relay on controlled differential housing (fig. 122).

(4) *Remove pull-back springs.* Grasp end of pull-back spring with heavy pliers and pull back until spring is clear of relay (fig. 122). Release spring gradually until it is free. Leave front end of spring connected to hull front plate.

(5) *Remove left propeller shaft guard.* Remove screw holding left propeller shaft guard to support brackets and remove guard.

(6) *Remove right propeller shaft guard.* Remove four screws holding right propeller shaft guard to support brackets and remove guard.



Figure 121. Disconnecting oil cooler hose.

(7) *Remove stop light switches.* Remove cotter pin and slide stop light switch rod off pin on relay arm (fig. 122). Remove two screws holding stop light switches to front differential mounting brackets. Lay switches to one side so they will not be damaged.

(8) *Drain oil.* Drain oil by removing small plate under hull floor at front of vehicle and remove differential drain plug. After oil has drained, reinstall plug.

(9) *Disconnect oil cooler lines.* Disconnect oil cooler lines at right rear corner of differential by unscrewing coupling on line from fitting on housing (fig. 120).

**Caution:** Place rags or container under lines to catch any oil that may drain out of cooler lines.

(10) *Remove final drive propeller shaft shields.* Remove four screws holding both halves of final drive propeller shaft shields to mounting brackets. Then remove the shields. Remove two screws holding shield brackets to sides of controlled differential housing and remove brackets.

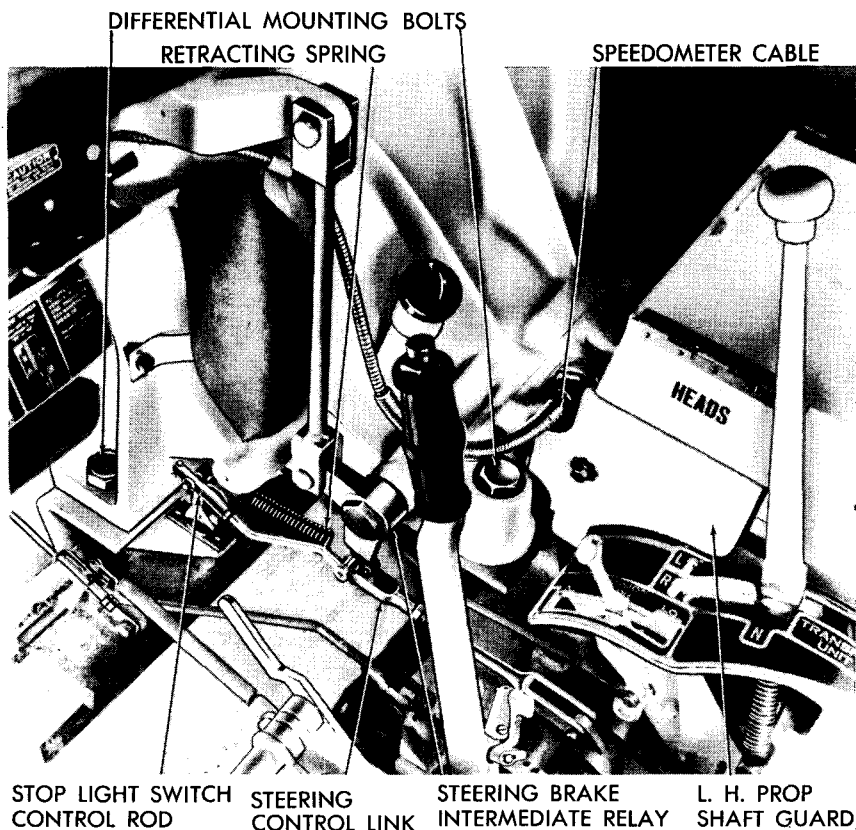


Figure 122. Steering brake linkage and differential mounting.

(11) *Disconnect inner ends of final drive propeller shafts.* Remove lock wires from inner universal joint bearing housing screws. Remove four screws holding universal joint bearing housings to controlled differential yoke. Slide yoke into controlled differential housing and disconnect joint.

(12) *Disconnect differential to transfer unit propeller shaft.* Remove lock wires from front universal joint bearing caps. Remove four screws holding bearing caps to differential yoke. Slide propeller shaft back, telescoping rear yoke on transfer unit output shaft and disconnect joint.

(13) *Disconnect speedometer cable.* Disconnect speedometer cable (fig. 122) on differential by unscrewing knurled nut on cable and pulling core out of case. Remove cable from slip on case and lay cable to one side.

(14) *Remove differential mounting bolts.* Remove two front and one rear differential mounting bolts and nuts and remove bolts.

(15) *Remove differential.* Attach chain hoist to lifting bracket on differential cover. Take up weight of differential on hoist until it clears mounting brackets on hull floor. Raise differential very slowly, and see that it does not strike instrument panel (fig. 123). Remove differential and lower to ground. Remove chain hoist.

c. **INSTALLATION.** (1) *Place differential in vehicle.* Attach a chain hoist to lifting bracket on differential cover. Raise differential over opening in hull front deck. Lower assembly, being careful that it does not strike instrument panel. Lower assembly on support brackets. Remove chain hoist from cover.

(2) *Install differential mounting bolts.* Install two front and one rear differential mounting bolts through boss on differential case and brackets on hull (fig. 122). Install nuts and washers and tighten nuts to 200 foot-pounds, using a torque wrench.

(3) *Install speedometer cable.* Place speedometer cable in clip on differential case. Slide speedometer core into drive shaft sleeve and install knurled nut holding cable to sleeve.

(4) *Connect transfer unit to controlled differential propeller shaft.* Slide propeller shaft forward, line up universal joint and install four screws holding bearing journals to differential yoke. Using a torque wrench, tighten screws to 80 foot-pounds. Lock screws in pairs with locking wire.

(5) *Connect inner ends of final drive propeller shafts.* Raise propeller shaft and position final drive bearing caps on differential drive yokes. Install screws holding bearing caps to yoke. Using a torque wrench, tighten screws to 80 foot-pounds. Lock screws in pairs with locking wire.

(6) *Install final drive propeller shaft shields.* Install brackets holding propeller shaft shields to side of differential housing. Position



upper and lower section of propeller shaft shield over mounting bracket and install eight screws and washers.

(7) *Connect oil cooler lines.* Insert oil cooler lines into fittings in controlled differential case and connect coupling on lines to fittings in case (fig. 120).

(8) *Refill controlled differential.* Fill controlled differential with approximately 20 quarts of engine oil. Recheck level on gage.

(9) *Install stop light switches.* Place stop light switches in position on front differential mounting brackets and install four screws and washers. Slide rod over pin on steering and braking relay and install flat washer and cotter pin (fig. 122).

(10) *Install right propeller shaft guard.* Place right propeller shaft guard against support brackets and install four screws and washers.

(11) *Install left propeller shaft guard.* Place left propeller guard against support brackets and periscope stowage box, and install screw and washer.

(12) *Install pull-back springs.* Make sure front end of spring is hooked to bracket on hull front plate. Pull back on end of spring

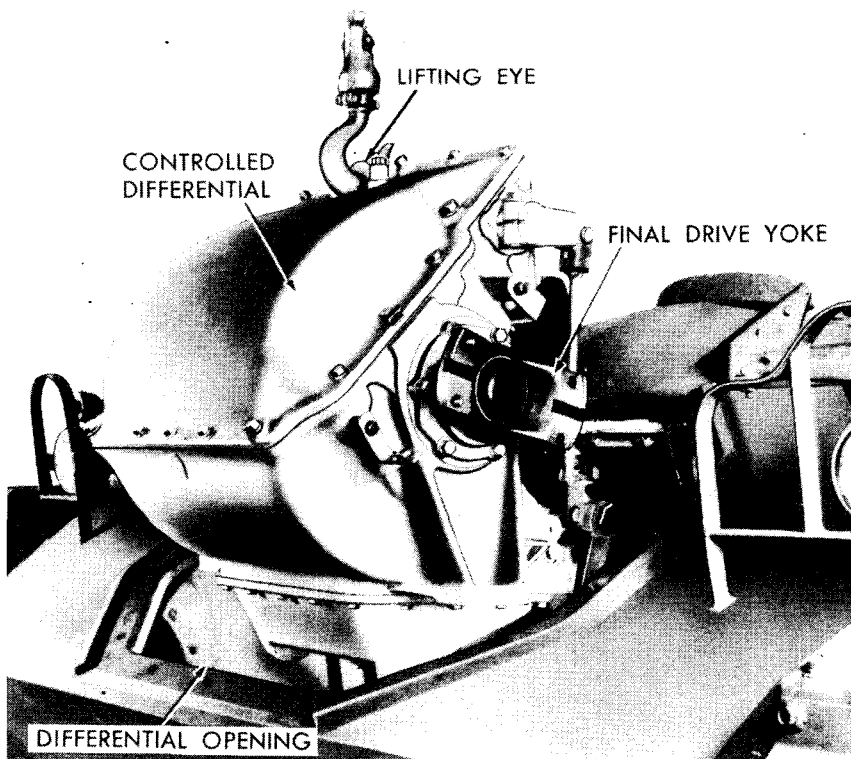


Figure 123. Removing controlled differential.

with large pliers, and hook end of spring over cut-out in steering and braking lever relay (fig. 122).

(13) *Connect brakes.* Line up hole in connecting rod yoke with hole in lower steering brake relay. Install clevis pin and cotter pin.

(14) *Adjust linkage.* Adjust length of connecting rod to permit free assembly of pin at steering lever by loosening lock nut and rotating clevis. Turn clevis one-half turn tighter to assure taking out all slack, and tighten lock nut. Connect rod to lever and install clevis pin and cotter pin. Adjust other lever in same manner.

(15) *Adjust steering brakes.* Refer to paragraph 134*b*.

(16) *Install spare periscope box.* Refer to paragraph 130*c*.

(17) *Install differential opening cover.* Refer to paragraph 135*b* (6).

**Section XXXI. FINAL DRIVE**

**139. Description and Data**

*a. DESCRIPTION.* The final drive units are mounted in separate housings bolted to the front of the hull on each side (fig. 125). The final drives are designed so that they are interchangeable right to left and can be installed on either side of the vehicle. Power is transmitted to the final drives from the controlled differential through short propeller shafts having large universal joints at each end. The herringbone gear set provides a reduction ratio of 2.94 to 1. Power output is through the sprocket shaft, which carries the track driving hub and sprockets.

*b. DATA.*

Bracket-----	Cast steel.
Cover-----	Cast steel.
Gear ratio-----	2.94 to 1.
Sprocket, teeth-----	13.
Type of gear-----	Spur (herringbone).

**140. Sprockets and Hubs**

*a. REMOVAL.* (1) *Break track.* Break track below and to the rear of final drive, and lift track over and to the rear of hub and sprockets (par. 144).

(2) *Remove sprocket and hub assembly.* Remove 10 nuts attaching hub to shaft and remove hub and sprocket as an assembly.

(3) *Remove sprockets.* Remove 13 screws attaching each sprocket to hub and remove sprockets.

*b. INSTALLATION.* (1) *Install sprockets.* Install sprockets on hub and tighten 13 screws on each sprocket securely.

(2) *Install hub assembly on shaft.* Position hub and sprocket assembly on shaft, line up holes, and install and tighten the 10 mounting nuts securely.

\*(3) *Install track.* Refer to paragraph 144b.

(4) *Adjust track.* Refer to paragraph 143b.

c. **REVERSING SPROCKETS.** When the teeth on the sprockets become worn from usage, the sprockets can be reversed on the hub or the complete hub and sprocket assembly can be changed from right to left, and vice versa. This will present a new tooth surface to the track and provide longer life.

## 141. Final Drive Replacement

a. **AUTHORITY.** Replacement of this major assembly with a new or rebuilt unit is normally a field maintenance operation, but may be performed in an emergency by organizational maintenance units, provided authority for performing this replacement is obtained from the appropriate commander. Tools needed for the operation which are not carried in organizational maintenance units may be obtained from a higher maintenance unit.

b. **REMOVAL.** (1) *Drain lubricant.* Remove cover plate that protects final drive drain plug from bottom of hull beneath final drive. Remove drain plug.

(2) *Remove guards.* Remove four screws holding halves of final drive propeller shaft guard to controlled differential and to final drive case, and remove guard.

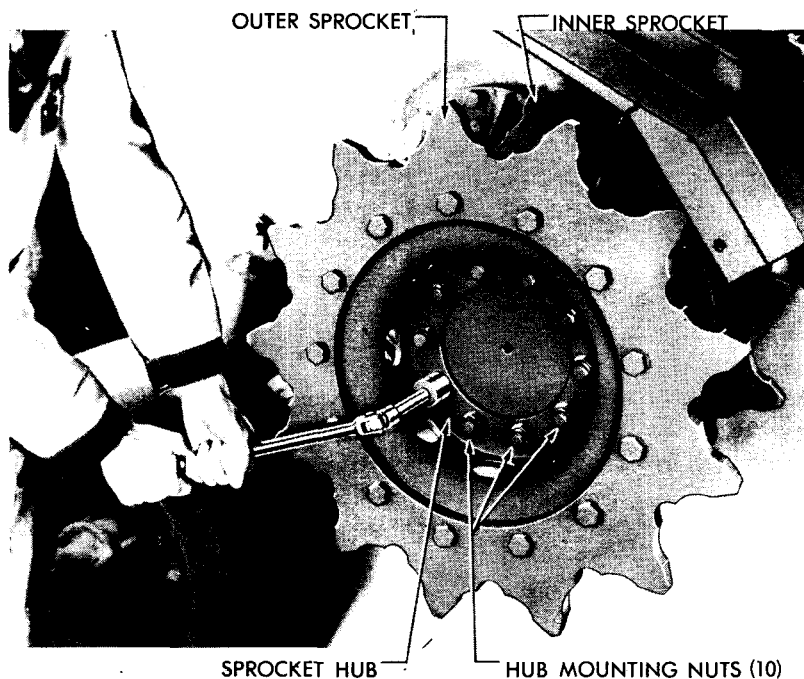


Figure 124. Removing track sprocket.

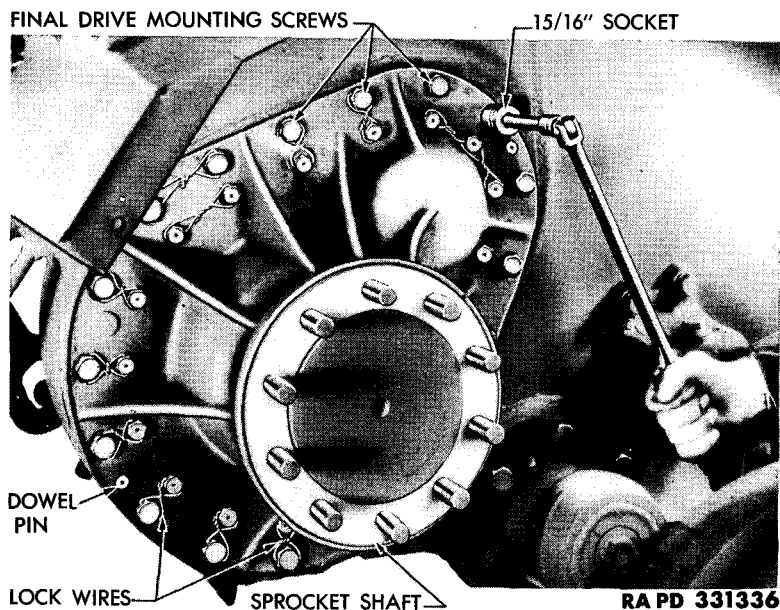


Figure 125. Final drive on vehicle.

(3) *Disconnect propeller shaft.* Remove locking wires and four screws holding the universal joint yoke on the final drive input shaft to the universal joint (fig. 114). Compress the final drive propeller shaft sufficiently to allow universal joint to clear yoke. Lower outer end of propeller shaft after tying the universal joint bearing caps to the cross with locking wires to prevent accidental disassembly.

(4) *Break track.* Refer to paragraph 144.

(5) *Remove sprocket and hub assembly.* Remove 10 nuts attaching hub to shaft, and lift hub and sprockets off as an assembly.

(6) *Remove final drive assembly.* Cut locking wires and break loose 18 screws (fig. 125) that hold bracket flange to hull side wall. Connect hoist to final drive sling (41-S-3832-35) and install on final drive bracket. Remove attaching screws, pry final drive assembly off dowels, and remove from vehicle (fig. 126).

c. *INSTALLATION.* (1) *Install final drive assembly.* Coat inner edges of bracket flange with sealing compound. Raise final drive assembly with hoist and sling (41-S-3832-35) and line up dowel pins and cap screw holes. Push the assembly into place and install the mounting cap screws, tightening them evenly to 170 to 180 foot-pounds torque. Install locking wires. Then remove sling.

(2) *Connect propeller shaft.* Push final drive propeller shaft toward differential and raise into position opposite yoke on final drive. Line up holes in yoke with holes in universal joint housings and install four screws holding bearing housings to yoke. Tighten screws to 130

to 140 foot-pounds torque and install locking wire through each pair of screw heads.

(3) *Install guards.* Position halves of propeller shaft guards around shaft and install four screws holding guard to controlled differential and final drive cover.

(4) *Install sprocket.* Refer to paragraph 149b.

(5) *Connect track.* Refer to paragraph 144b.

(6) *Adjust track.* Refer to paragraph 143.

(7) *Add lubricant.* Make sure drain plug and protecting plate are reinstalled. Add engine oil to filler opening until oil reaches top of lower of two filler openings. Approximately 4½ pints of oil are required. Reinstall filler plug.

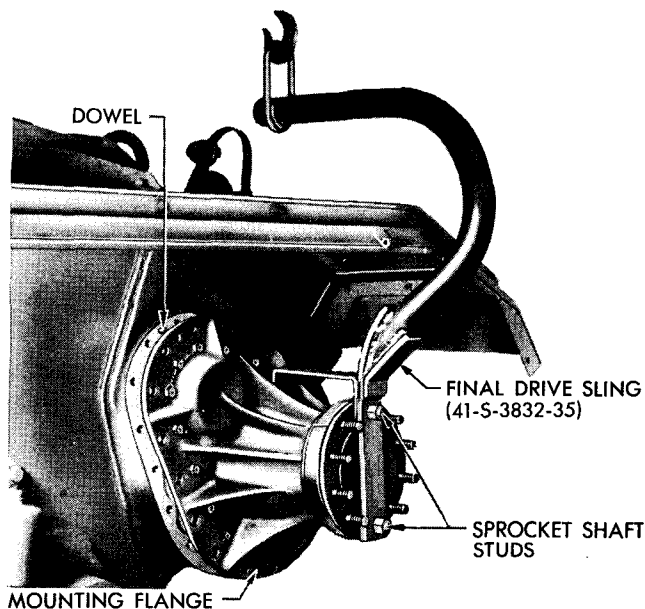
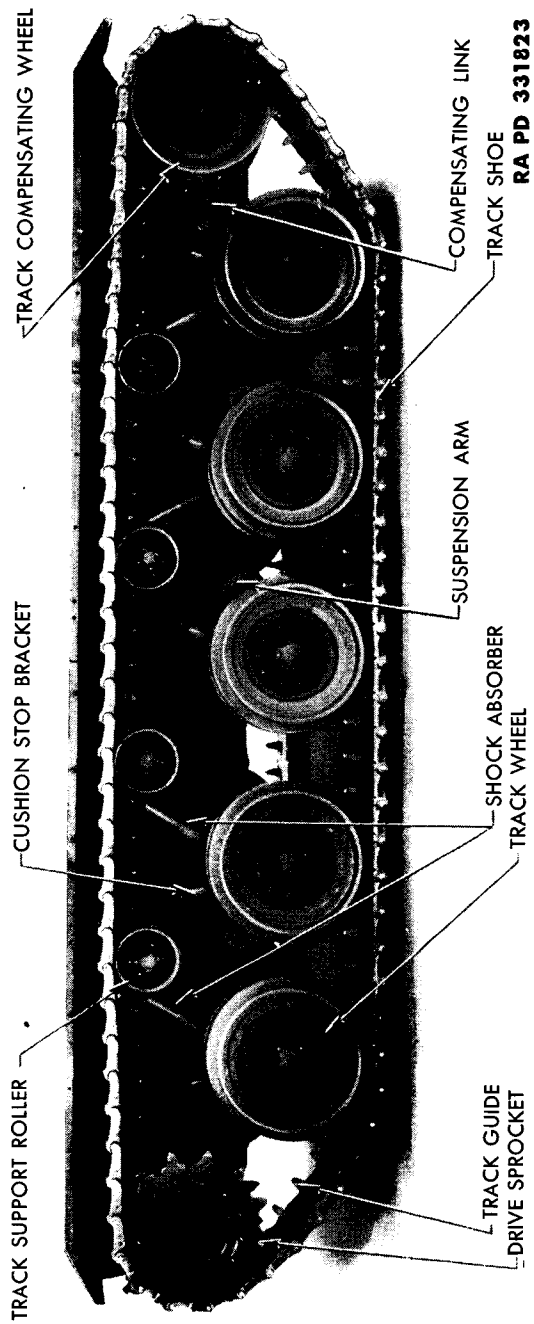


Figure 126. Removing final drive assembly.

## Section XXXII. TRACKS AND SUSPENSION

### 142. Description and Data

a. DESCRIPTION. (1) Two individually driven steel tracks, 16 inches wide, provide the necessary traction to propel the vehicle (fig. 127). Each complete track is composed of separate track shoes of cast steel with center guides, connected together with straight pins carried in rubber bushings (fig. 130). The shoes are of interlocking design to eliminate vibration and wear that occurs when track wheels pass over openings between track shoes. Two drive sprockets, one on each side, pull the tracks forward over the supporting rollers and lay them down in the path of the advancing track wheels.



*Figure 127. Track suspension system.*

(2) There are 10 dual track wheels, 5 on each side, which are carried on individual arms attached to independent torsion bars and mounted so as to be easily removable (fig. 127). The 10 arms are each mounted on 2 roller bearings carried in housings bolted to the sides of the hull just above the floor level. The arms are splined to the torsion bars, which extend through protective tunnels on the hull floor. The torsion bars for opposite wheels are staggered to permit carrying the wheels at the same level. Double-acting, airplane-type, hydraulic shock absorbers are provided for the two front and two rear suspension arms on each side, and are mounted directly on the hull side walls (fig. 127).

(3) An adjustable compensating wheel for each track is mounted at the rear of the hull, and is connected to the rear-track wheel arm by a link (fig. 136). The link is so arranged that any decrease in track tension caused by lifting of the rear track wheels will be offset by movement of the compensating wheel toward the rear, and any increase in track tension caused by dropping of the rear track wheels will be offset by movement of the compensating wheel toward the front.

(4) Four dual, rubber-tired track support rollers are mounted on each of the upper hull sides (fig. 127) to support the track as it returns to the drive sprocket.

*b. DATA. (1) Track shoes.*

Number per track-----	80.
Width-----	16 inches.
Type-----	Steel, with center guide and rubber bushings.

*(2) Track.*

Pitch-----	51½ inches.
Ground contact:	
Zero penetration-----	122 inches.
1-inch penetration-----	126 inches.

*(3) Suspension arms.*

Number (each side)-----	5.
Type-----	Solid steel.
Type of springing-----	Torsion bar.
Number of bearings-----	2 (straight-roller).

*(4) Track wheels.*

Number (each side)-----	5.
Type-----	Dual, demountable, rubber-tired.
Number bearings (each wheel)-----	2 (taper, roller).

*(5) Torsion bars.*

Number (each side)-----	5.
Type-----	Solid steel.

## Installation identification :

<i>Position</i>	<i>Part No.</i>
Left, Nos. 1 and 2-----	D60591B
Right, Nos. 1 and 2-----	D60591A
Left, Nos. 3, 4, and 5-----	7053475
Right, Nos. 3, 4, and 5-----	7053474

### (6) *Track support rollers.*

Number (each side)----- 4.

Type ----- Dual, demountable, rubber-tired.

Bearings----- 2 (taper, roller).

### (7) *Shock absorbers.*

Number (each side)----- 4.

Type ----- Hydraulic, airplane-type.

### (8) *Suspension arm cushion stops.*

Number (each side)----- 5.

Type ----- Volute spring.

## 143. Track Adjustment

### a. GENERAL.

**Caution:** It is important that the tracks be properly adjusted to prevent unnecessary wear and breakage.

b. PROCEDURE. (1) To check the track adjustment, move vehicle to level ground to assure normal track tension. Place a 4-foot pry bar and improvised hook between the track and suspension arm housing at a point midway between the second and third track support rollers. Pry down with lever so that about 200-pounds pressure is exerted at track and, at the same time, lay a straightedge along the top of the track between the second and third rollers and measure the sag

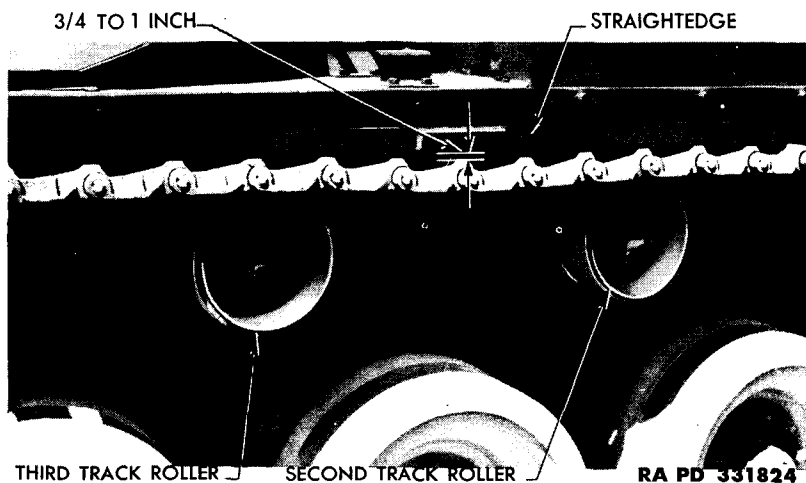
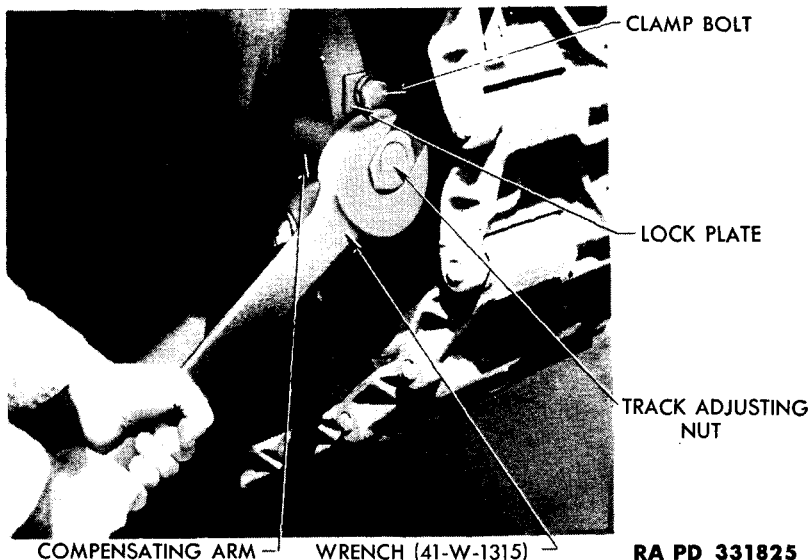


Figure 12S. Testing track tension.





*Figure 129. Adjusting track tension.*

at this point (fig. 128). This sag should be from  $\frac{3}{4}$  to 1 inch with 200-pounds load applied. Track tension must be adjusted to above figure when sag becomes  $1\frac{1}{2}$  inches or more.

(2) If the track adjustment is incorrect, loosen clamp bolt at rear of compensating wheel arm (fig. 129) and slide lock plate up from adjusting eye bolt sleeve nut. Tighten or loosen adjusting sleeve nut to obtain correct track tension. Tighten clamp bolt after positioning lock plate on flat of adjusting sleeve nut.

## 144. Track Replacement

*a. REMOVAL.* Install track fixtures (41-F-2997-86) on track midway between compensating wheel and rear track wheel (fig. 131), and take up track tension. Remove track shoe pin wedge screw, lock washer, and flat washer (fig. 130). Using a brass drift, drive wedge out of block. Tighten track fixtures to relieve track tension and drive out connecting pin, using knock-out pin (41-P-560-300) (fig. 131). Remove fixtures, start engines, and put transfer unit and transmission shift levers in drive position and run engines just fast enough to turn track drive sprocket slowly. Then run upper half of track forward off support rollers and drive sprockets. Tow vehicle off track. If new track is to be installed, place new track in front of old track and tow vehicle onto new track.

*b. INSTALLATION.* Lay track out on ground and tow vehicle on track so that rear end of track projects approximately 10 inches beyond rear track wheel. Pull front end of track up over drive sprocket and start engines, put transfer unit in reverse and transmission in

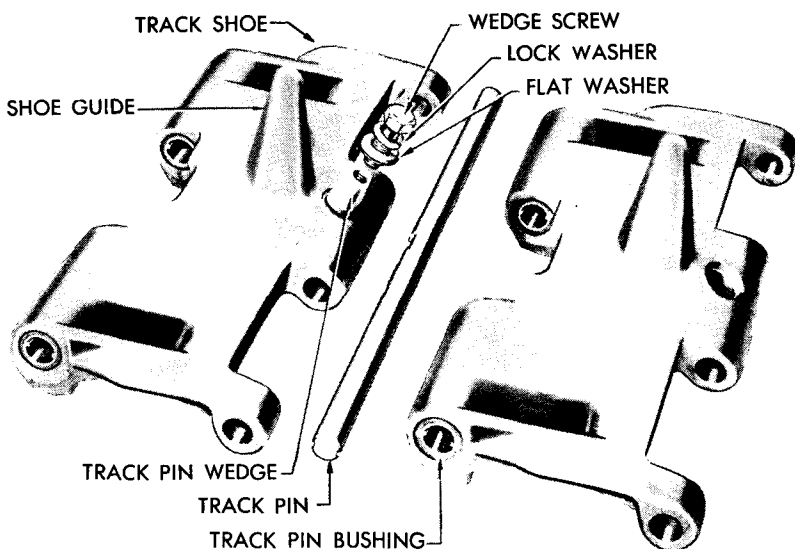


Figure 130. Track block—disassembled.

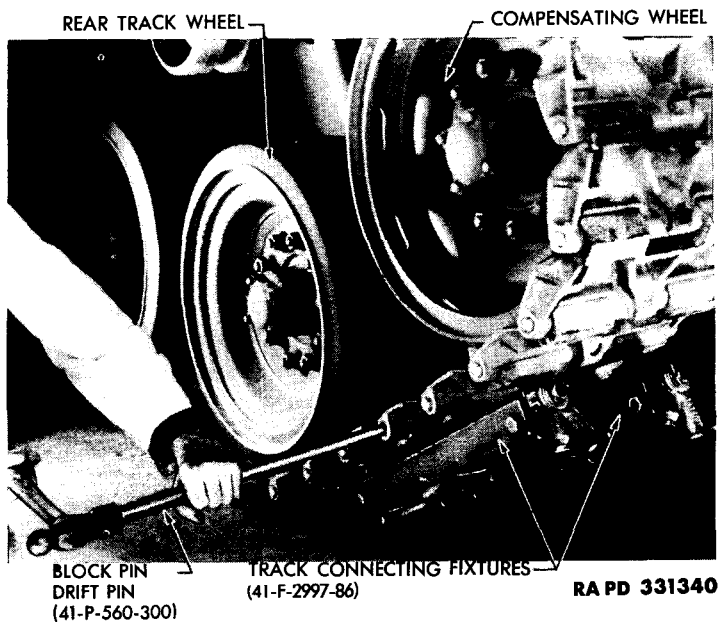
drive, and guide track back over support rollers and compensating wheel as rotation of drive sprocket moves upper half of track back. Mount track connecting fixtures (41-F-2997-86). Bring track ends together by tightening fixture and drive in track shoe pin (fig. 132). Be sure that slots in pin enter guides in pin bushing (fig. 130) and that pin enters bushings without damaging bushing ends. Install track shoe pin wedge in hole in shoe with beveled end in, tap wedge lightly to its seat, and install flat washer, lock washer, and wedge screw. Tighten screw to 110 foot-pounds. After run in, retighten screw to 80 to 90 foot-pounds. Adjust track tension (par. 143).

**Caution:** Be sure to install track so that grouser on block contacts ground first as shown in figure 1.

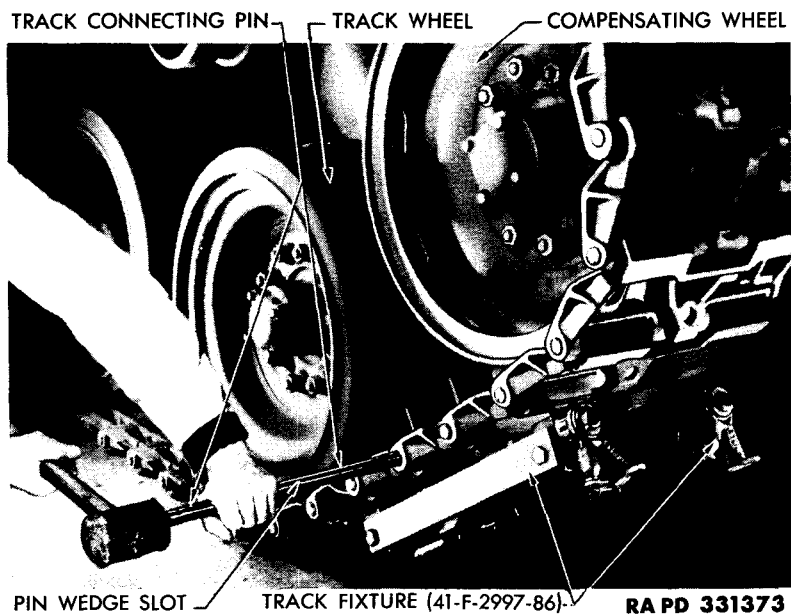
## 145. Compensating Wheel, Bearings, and Seals

*a. REMOVAL.* Break track at rear of vehicle (par. 144*a*) and pull top half of track forward to clear compensating wheel. Remove 10 nuts and locks holding dual compensating wheel on studs and remove wheels. Remove four hub cap mounting screws, and remove hub cap and gasket. Take out cotter pin, nut, and washer holding hub on spindle (fig. 136). Pull out on hub enough to loosen outer bearing. Remove outer bearing. Lift off hub and inner bearing. Pry grease seal off spindle bearing spacer with screw driver.

*b. INSTALLATION.* Place new oil seal on spindle with feather edge toward arm and, using oil seal replacer (41-R-2383-950), tap over bearing spacer until seal contacts spacer (fig. 140). Place wheel hub on bench with wheel side down and pry grease retainer out of hub.



*Figure 131. Removing track pin.*



*Figure 132. Connecting track.*

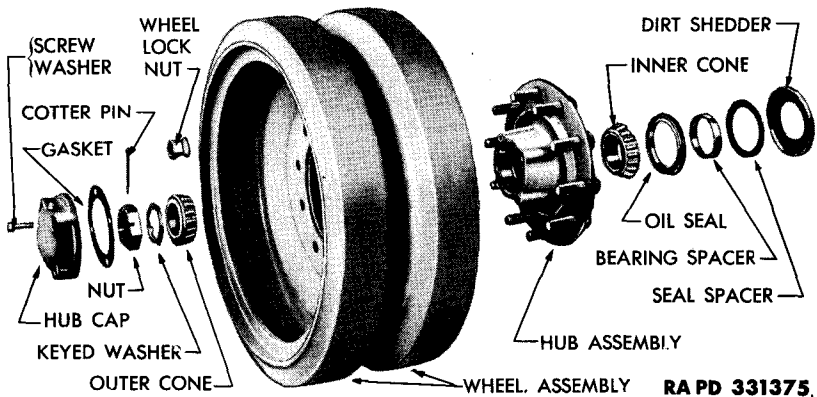


Figure 133. Wheel hubs, bearings, and seals—disassembled.

Place new grease retainer in replacer (41-R-2390-450) (fig. 134) and position replacer on hub. Drive retainer carefully into position (fig. 135) to prevent cocking in hub and remove tool. Check retainer to see that it is square in the hub counterbore and that the flange of retainer is true. Grease inner roller bearing assembly thoroughly with lubricant and push on spindle shoulder until bearing contacts spacer. Push hub assembly on spindle, making sure inner bearing enters race in hub. Fill outer roller bearing with grease and install on spindle, holding wheel hub centered on spindle and pushing outer bearing into race. Install keyed washer on spindle and seat on bearing. Install nut on spindle.

c. **ADJUSTMENT.** Rotate hub and, at the same time, tighten nut to 200 foot-pounds torque. Back off nut until there is no torque, then retighten nut to 75 foot-pounds torque. Back off nut to first cotter pin hole with minimum travel of 15° and install cotter pin. If first hole is less than 15° travel, back off nut to next hold or 30° more. Position hub cap and install four mounting screws. Using pressure gun, force more grease into hub until it starts coming out of grease shield at rear. Wipe off all excess grease. Lift wheels and install on hub studs, the first wheel with concave side in, the second with concave side out. Install 10 nuts with locks and tighten evenly with 250 to 300 foot-pounds. Install and adjust track (pars. 144b and 143b).

## 146. Compensating Arm and Lever

a. **REMOVAL.** Remove compensating wheel and hub as previously outlined in paragraph 145a. Remove cotter pin, nut, and washer from compensating link bolt at rear end of link. Install slide hammer adapter (41-A-18-245) on link bolt head, being sure that stud is screwed all the way in bolt and hexagon shoulder of adapter seats on

bolt head. Attach slide hammer puller (41-P-2957-33) and pull bolt (fig. 137). Push link end down and out of compensating lever. If necessary, hook hoist on rear suspension wheel and raise wheel. This will move link end to rear of vehicle so that drift and hammer can be used to drive out bolt. Remove six attaching screws and remove compensating arm cover (fig. 136); then discard gasket. Remove lock ring holding arm and lever on compensating wheel spindle and lift support arm and lever off spindle as an assembly. Remove screws holding spindle to tapping plate on hull and remove spindle.

b. INSTALLATION. Coat flange of spindle with sealing compound and position spindle on hull tapping plate, and install eight mounting screws dipped in sealer. Tighten screws to 240 to 260 foot-pounds, using torque wrench. Install arm and lever assembly on spindle, seeing that shoulders on spindle enter bearing races and that grease seal slips over bearing spacer. Install snap ring on spindle end to hold assembly. Using new gasket, position compensating arm cover and install six attaching screws. Connect compensating link to lever (fig. 136) and drive in bolt, using a soft hammer; then install washer, nut, and cotter pin. Tighten washer and nut on connecting bolt to 180 foot-pounds minimum. Install compensating wheel and hub (par. 145b) and adjust (par. 145c).

c. COMPENSATING ARM BEARING REPLACEMENT. (1) *Remove compensating arm and lever.* Refer to a above.

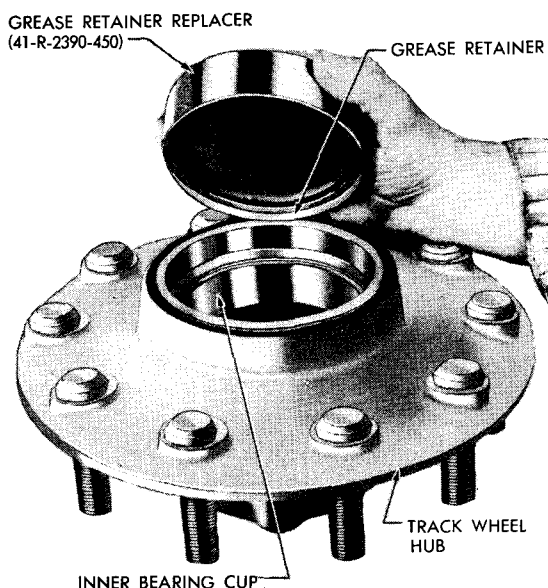


Figure 134. Wheel hub grease seal retainer in tool.

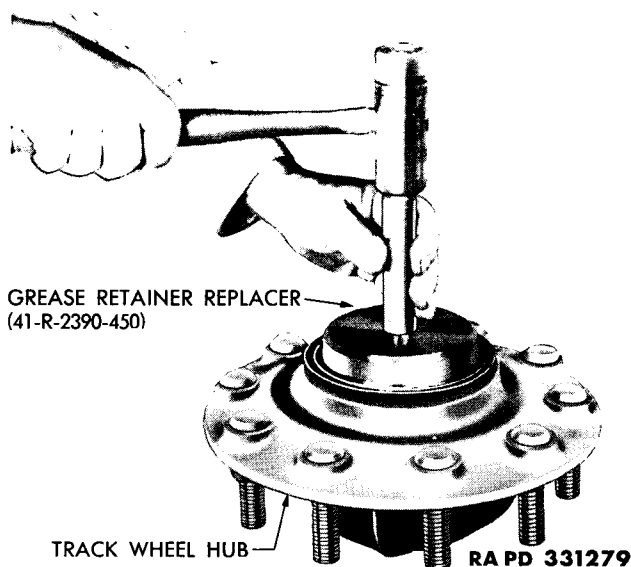
(2) *Remove bearings.* Remove lever clamping bolt, lock plate, and washer (fig. 130). Remove adjusting sleeve nut and thrust washer. Remove lever with adjusting eye bolt from support arm body. Tap inner roller bearing and grease retainer out of wheel support arm. Tap out the outer ball bearing.

(3) *Install bearings.* Grease bearings thoroughly with specified lubricant. Reinstall bearings in support by tapping in until they seat on shoulders in arm, using a block of wood or a brass drift. Place new grease seal in inner side of arm with featheredge toward vehicle and tap in until it seats on shoulder of arm. Install adjusting eye bolt in lever, and place adjusting sleeve nut (thoroughly greased with lubricant) and thrust washer on eye bolt. Install lever with eye bolt and nut on arm. Install lock plate and lock washer on clamp bolt and turn bolt into lever.

(4) *Install compensating arm and lever.* Refer to *b* above.

## 147. Compensating Link

*a. REMOVAL.* Remove compensating wheel and hub (par. 145*a*). Remove nut, cotter pin, and washer from inside end of compensating link rear bolt. Install adapter (41-A-18-245) on link bolt, attach slide hammer (41-P-2957-33) to adapter, and pull bolt (fig. 137). Working at front end of compensating link, remove bolt holding link to rear suspension arm in same manner, and remove link.

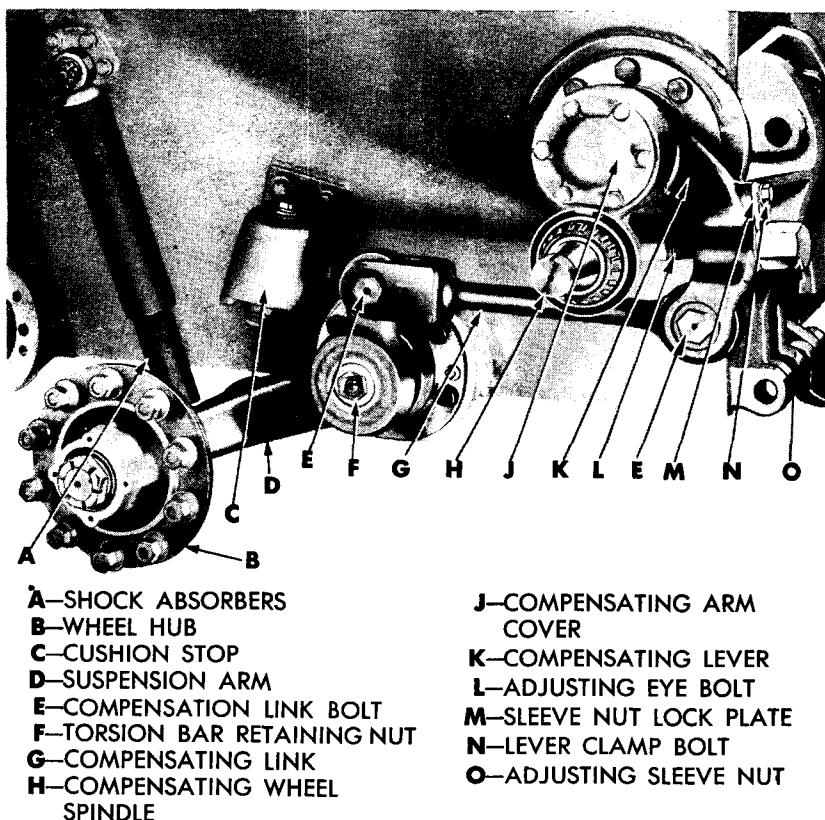


*Figure 135. Installing wheel hub grease seal retainer.*

b. **INSTALLATION.** Lift compensating link into position on rear suspension arm (fig. 136) and line up connecting bolt holes. Place compensating link bolt in position and drive in, using a soft-faced hammer. Install washer and nut on bolt and tighten to 180 foot-pounds minimum. Connect rear end of link to compensating arm in the same manner. Install compensating wheel and hub (par. 145b) and adjust (par. 145c). Connect track and adjust (pars. 144b and 143b).

## 148. Track Wheels, Bearings, and Seals

a. **REMOVAL.** (1) *Remove wheel.* If wheel lifter (41-L-1400) is available, proceed as follows: Loosen track adjusting sleeve nut several turns to relieve track tension. Place wheel lift block over track guides between drive sprocket and No. 1 track wheel. Drive vehicle forward slowly until wheel to be removed rests on center of block (fig. 138). Place suspension arm hook under suspension arm and over top of



**RA PD 331948**

*Figure 136. Compensating wheel linkage.*

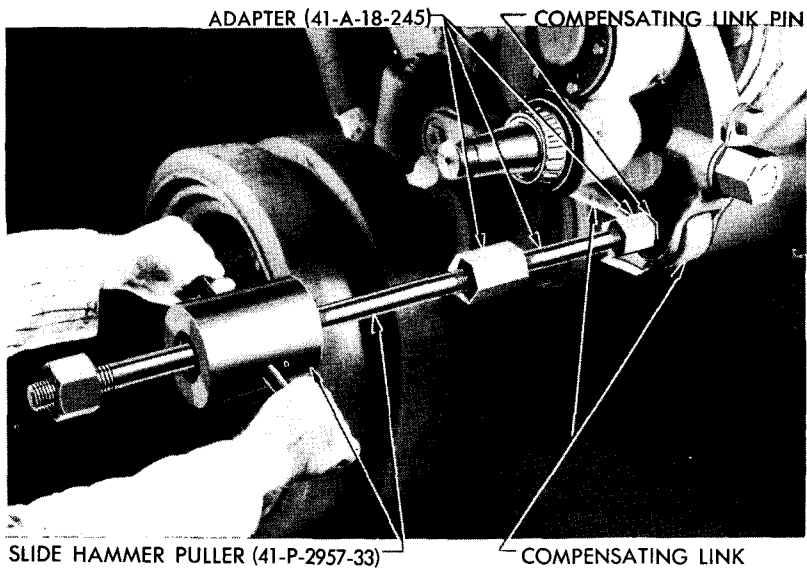


Figure 137. Removing compensating link pin.

cushion stop bracket, making sure that top of hook is between spring mounting screw and bracket mounting screws (fig. 138). Drive vehicle slowly either forward or backward until track wheel next to the one to be removed rests on top of the wheel lifting block. Set brakes and stop engines. Remove 10 nuts holding wheels to hub and lift off wheel. If wheel lifter (41-L-1400) is not available, set brakes and place a block of wood (2 by 4 inches or 2 by 6 inches) against inside edge of track. Position hydraulic jack with base of jack on track and block of wood under suspension arm to be lifted (fig. 139). Lift suspension arm until wheel clears track guides. Remove 10 nuts holding dual wheels to hub and lift off wheels.

**Caution:** Exercise care in lifting arm to prevent arm end from slipping off jack as a lift of approximately 9,000 pounds is required to raise arm sufficiently to remove wheels.

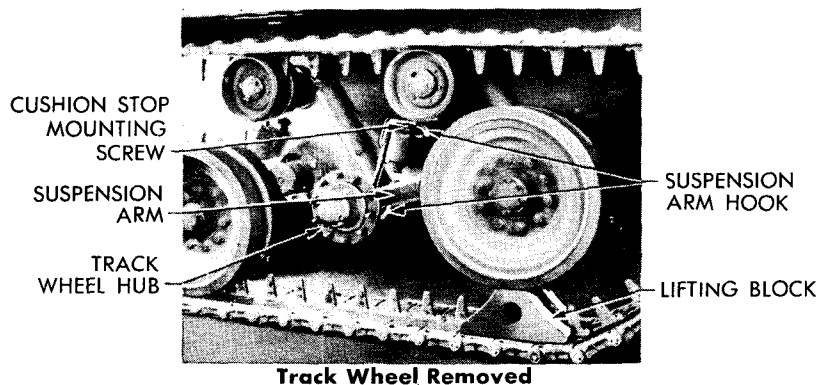
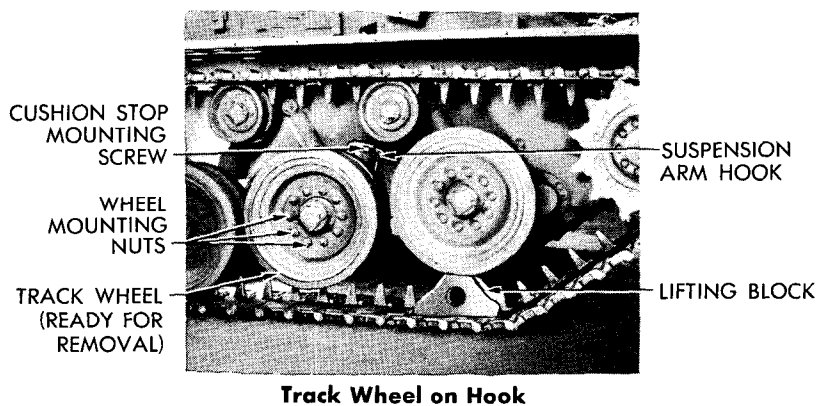
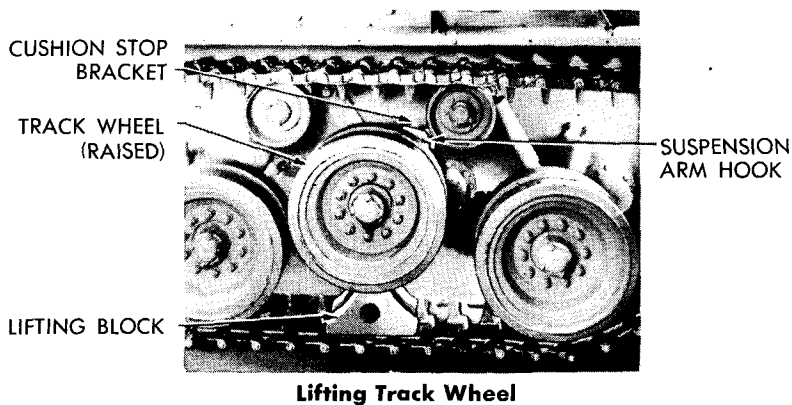
(2) *Remove wheel hub.* Remove four hub cap mounting screws (fig. 133), remove cap, and discard gasket. Remove cotter pin, nut, and keyed washer that hold hub assembly on spindle. Pull hub out enough to move outer roller bearing out of cup in hub, and remove bearing. Pull hub assembly off spindle, and remove inner bearing.

(3) *Remove oil seal.* Pry oil seal off bearing spacer on spindle (fig. 133) and discard.

**Note.** Exercise care in prying off seal, or dirt shedder in back of seal will be damaged necessitating installation of new shedder.

Place hub assembly on bench with wheel side down and pry out grease retainer (fig. 134).





*Figure 138. Lifting track wheel, using lifter (41-L-1400).*

(4) *Remove bearing races.* Drive bearing races out of hub carefully, using a brass drift and a hammer.

b. **INSTALLATION.** (1) *Install bearing races.* Drive bearing races into wheel hub, using a brass drift or block of wood and being careful to prevent cocking of race in hub.

(2) *Install oil seal.* Place new oil seal over spindle with feather-edge of seal toward arm and, using oil seal replacer (41-R-2383-950), drive seal into position on bearing spacer (fig. 140). Place new grease retainer in replacer (41-R-2390-450) (fig. 134), and position replacer on hub. Drive retainer into position (fig. 135) carefully to prevent cocking in hub, and remove tool. Check retainer to see that it is square in hub counterbore and that the flange in retainer is true.

(3) *Install wheel hub.* Pack inner roller bearing thoroughly with specified grease and push on spindle and over shoulder. Lift hub assembly onto spindle and over inner bearing. Pack outer bearing with grease and push on spindle and into race in hub, centering hub on spindle. Install keyed washer and bearing retaining nut. Adjust wheel bearing (par. 145c). Place hub cap on hub using new gasket, and install four mounting screws. Connect lubricating gun to fitting on hub and force grease into hub until excess grease comes out in back of hub. Wipe off all excess grease.

(4) *Install wheel.* Position dual track wheels on hub. Install 10 mounting nuts and tighten to 250 to 300 foot-pounds. If wheel lift

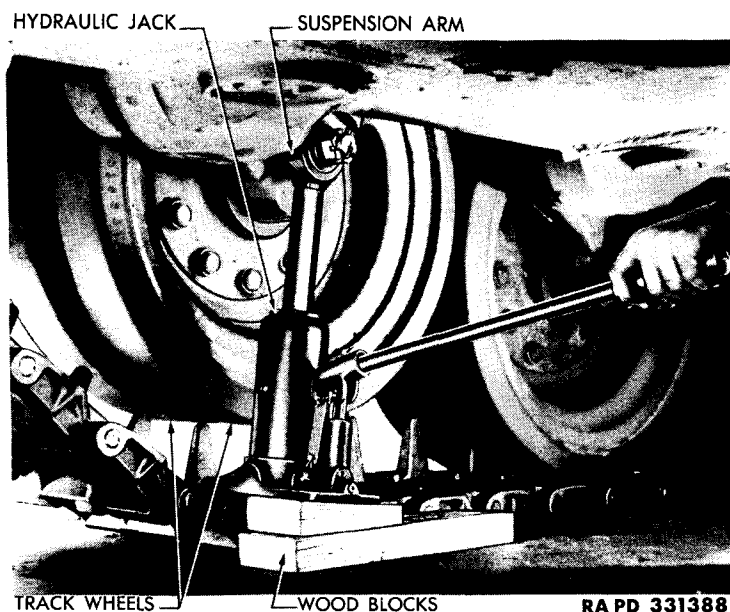
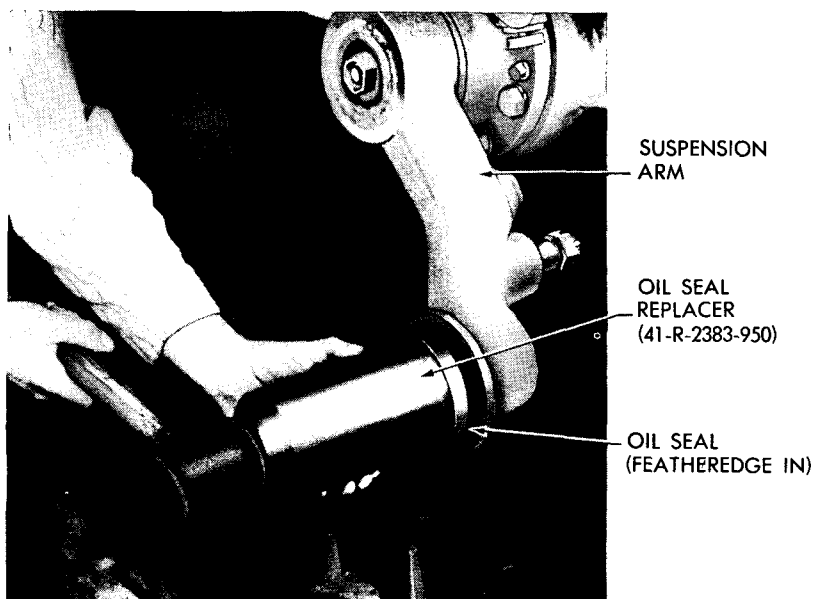
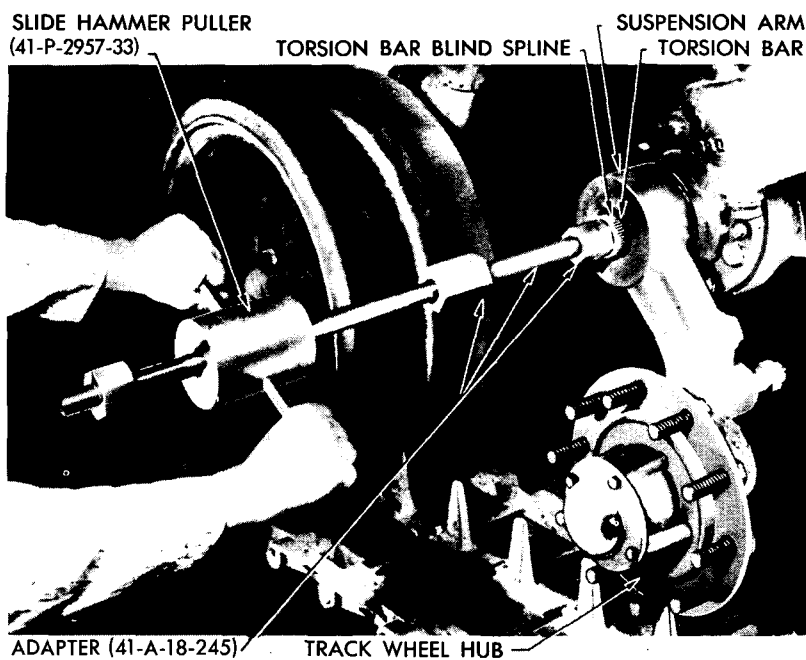


Figure 139. Lifting track wheel with hydraulic jack.



*Figure 140. Installing wheel hub seal.*



*Figure 141. Removing torsion bar.*

was used for removing wheels, drive vehicle forward or backward slowly until track wheel lifting block is under wheel supported by suspension arm hook. Remove hook from suspension arm and cushion stop bracket. Drive vehicle in reverse slowly until lifting block is between drive sprocket and No. 1 wheel. Remove lifting block. Adjust the track (par. 143b). If wheel lift was not available and wheels were removed by using a hydraulic jack, position wheels on hub, install mounting nuts, and tighten to 250 to 300 foot-pounds. Lower track wheels to track and remove hydraulic jack and blocking.

## 149. Torsion Bars

*a. REMOVAL.* (1) *Disconnect shock absorber.* Disconnect shock absorber at lower end (par. 152a).

(2) *Remove track wheel.* Place hydraulic jack under vehicle so that base of jack rests on track and block of wood and top of jack is under suspension arm. Raise arm high enough to remove the wheel. After wheels are removed, lower jack until all tension is removed from torsion bar.

(3) *Remove torsion bar.* Remove screw that holds torsion bar to bar retaining nut. Remove bar retaining nut. Screw adapter (41-A-18-245) for slide hammer into torsion bar, being sure that stud is screwed all the way in bolt and hexagon shoulder of adapter seats on bolt head. Attach slide hammer puller (41-R-2957-33) to adapter, and pull shaft out of suspension arm (fig. 141).

*b. INSTALLATION.* (1) *Identifying torsion bars.* The suspension arm torsion bars have designating arrows stamped on the arm end. The arrows indicate the rotation of the bars when the wheel and arm are raised, or in other words, the direction of bar "spring." The two front wheel bars on the right-hand side of the vehicle have designating arrows in clockwise rotation. The two front wheel bars on the left-hand side of the vehicle have arrows pointing in the counterclockwise rotation. The three rear suspension arm torsion bar on the right-hand side of vehicle have an arrow indicating counterclockwise, and the three rear arm torsion bars on the left-hand side of the vehicle have clockwise arrows. Be sure to install torsion bars in the correct locations. The two front bars on each side are smaller diameter bars and must be reinstalled in this position.

(2) *Install torsion bars.* The suspension arm torsion bars have designating arrows and part numbers stamped on arm end. The arrows indicate the rotation of the bars when the wheel and arm are raised. Slide the correct torsion bar into the tunnel until the inner end of the bar contacts the anchor. See paragraph 142 for torsion bar identification and position. Examine the outer end of the torsion bar and rotate it until the small slot that is cut in the chamfer is straight up (vertical). This will also insure a vertical blind spline at the

anchor end of the bar; a requirement for proper entry of the bar into its anchor. Gently tap the bar into the anchor with a soft-faced hammer. If the bar will not enter readily, loosen the cap screws holding the anchor supporting plate a little more and make certain that the four cap screws are loosened approximately the same amount. The two cap screws holding the anchor to the supporting plate do not have to be loosened. After the torsion bar has entered the anchor, raise the suspension arm until the small slot cut in the outer edge of the arm lines up with the blind spline in the outer end of the torsion bar. The torsion bar can then be tapped all the way into place. Install the torsion bar retaining nut and tighten to 75 foot-pounds. Install the cap screw in the retaining nut and tighten it to 65 foot-pounds. Tighten the torsion bar anchor plate screws to 35 foot-pounds.

(3) *Install track wheel.* Position hydraulic jack and block of wood under suspension arm on track edge, and raise arm until wheel can be installed. Position dual track wheel on hub studs and install ten wheel mounting nuts. Tighten nuts to 250 to 300 foot-pounds. Lower wheel to track and remove jack and blocking.

(4) *Connect shock absorber.* Connect shock absorber lower end to suspension arm (par. 152b).

## **150. Suspension Arm**

*a. REMOVAL.* Remove track wheel and torsion bar (par. 149a). Remove seven screws that hold suspension arm assembly to hull side and lift or hoist arm out of hull opening.

*b. INSTALLATION.* Coat suspension arm mounting plate flange on hull with joint and thread compound (cement, type II). Lift or hoist arm assembly into position on hull side and line up mounting screw holes with a drift punch. Dip seven arm-mounting screws in joint and thread compound, install in arm flange, and tighten to 240 to 260 foot-pounds. Install torsion bar and track wheel (par. 149b).

## **151. Track Support Rollers, Bearings, and Seals**

*a. ROLLER REMOVAL.* Place block of wood on track wheel nearest roller to be removed. Set jack on wood block and raise track until it clears roller (fig. 142). Remove five screws that hold roller mounting bracket to hull side wall, and remove roller.

*b. TRACK SUPPORT ROLLER INSTALLATION.* Coat flange of roller mounting bracket with joint and thread compound (cement, type II). Lift support roller assembly up until track guides enter space between rollers, and position mounting bracket on hull side wall. Line up mounting screw holes in bracket flange and hull side wall. Dip mounting screws in joint and thread compound and install, drawing up evenly.

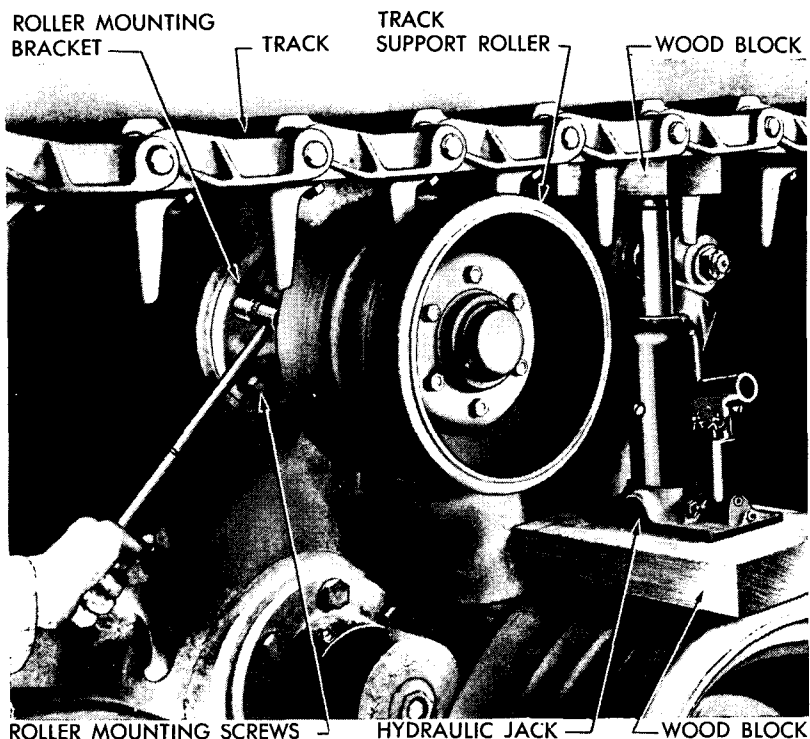


Figure 142. Removing track support roller.

**c. BEARING AND SEAL REPLACEMENT.** (1) *Removal.* Remove track support roller as outlined in *a* above. Remove four screws that hold hub cap to wheel hub, remove cap, and discard gasket. Remove cotter pin and nut that hold bearings on roller spindle. Pull out on roller to move outer bearing and keyed washer out of roller hub. Remove outer bearing and washer. Lift roller and hub assembly off mounting bracket spindle. Remove inner bearing and grease retainer. Pry grease seal off bearing spacer and discard.

*Note.* Remove grease seal carefully to prevent damage to dust shedder.

Remove bearing races from hub, using puller (41-P-2905-60).

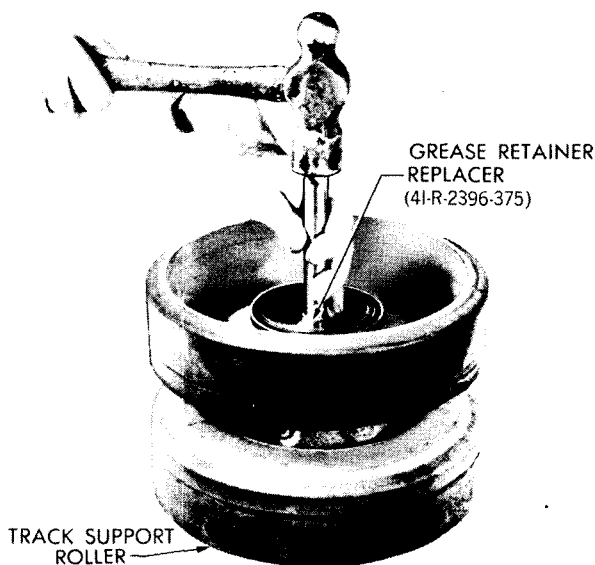
(2) *Installation.* Install bearing races in roller hub by driving carefully into place with brass drift or block of wood until they seat in shoulders of hub. Place new grease seal on support spindle with featheredge toward mounting bracket and drive into position on bearing spacer, using seal replacer (41-R-2397-875) (fig. 144). Place new grease retainer in position on replaced (41-R-2396-375) with flanged edge against shoulder of tool, and drive into support roller (fig. 143), until it seats on hub shoulder. Pack inner bearing with specified grease and position on spindle. Install roller and hub assembly on

spindle and over grease seal and inner bearing, being careful to prevent buckling grease seal leather. Pack outer bearing with specified grease, and install on spindle and into race in hub. Install keyed washer and nut on spindle, and tighten adjusting nut to 150 foot-pounds torque. Back off nut until there is no torque. Retighten nut to 75-foot-pounds torque. Back off nut to first cotter pin hole with minimum travel of 15° and install cotter pin. If first hole is less than 15° travel, back off to next hole or 30° more. Using new gasket, position hub cap and install four screws. Install support roller assembly (*b* above).

## 152. Shock Absorbers

*a. REMOVAL.* Working at upper end of shock absorber, remove cotter pin, nut, and washer that hold end of shock absorber to mounting bracket on hull side. Screw puller (41-P-2907-196) on bushing flange of shock absorber. Hold body of puller with large crescent wrench and turn down puller bolt, pulling shock absorber off pin (fig. 145). Working at lower end of shock absorber, remove cotter pin, nut, and washer that hold shock absorber to mounting pin on suspension arm. Using puller (A7079316), remove lower end of shock absorber from mounting pin in same manner.

*Note.* Use of a longer  $\frac{3}{4}$  16NF 2-bolt in shock puller will permit pulling lower end of shock absorber completely off pin.



*Figure 143. Installing track roller hub grease retainer.*

b. **INSTALLATION.** Lift shock absorber into position, and enter upper end bearing over mounting bracket pin. Drive bearing into position on mounting bracket carefully with a soft-faced hammer, install washer and nut, and tighten nut to 180 foot-pounds, using a torque wrench. Install cotter pin. Mount lower end of shock absorber on pin in suspension arm in the same manner.

### **153. Suspension Arm Cushion Stop**

a. **REMOVAL.** Remove bolt and spacing washer that hold volute spring in stop bracket and remove spring. Remove two bolts inside of stop bracket that hold assembly to hull side wall. Remove two mounting bolts that hold upper end of stop bracket on hull side (fig. 136), and remove stop bracket.

b. **INSTALLATION.** Identify proper cushion stop bracket for right and left sides. When bracket is properly installed, the boss on the bottom of the bracket should point forward toward the wheel and install two upper screws and washer. Threads of screws should be well coated with sealing compound before installation. Working under stop bracket, install two lower mounting screws and washer. Tighten the four attaching screws to 80 to 85 foot-pounds torque.

## **Section XXXIII. HULL**

### **154. Description and Data**

a. **DESCRIPTION.** (1) The hull of the vehicle is a completely welded structure except for portions of the front, top, and floor, which are removable for service operations. These removable portions consist of a plate above the controlled differential at the front of the vehicle, two drivers' doors over the drivers' seats, a hinged air outlet door over the engine compartment, an air inlet grille over the radiator compartment, two stowage compartment doors at rear and removable covers (on each side) over each fuel tank and over each battery. Openings in the bottom of the hull include the two large inspection plates, one under each engine and transmission; and the small covers just beneath the drain plugs for the engines, hydramatic transmissions, transfer unit, controlled differential, and final drives.

(2) The hull floor carries the mounting brackets for the engine and transmission supports, the transfer unit supports and the differential supports. It also incorporates the tunnels in which the torsion bars for the track suspension wheels are carried. The hull is divided into three compartments: The driving compartment at the front, an engine compartment at the center, and the stowage compartment and gun mount platform at the rear. The two front compartments are separated by a bulkhead that extends from side-to-side and from the roof down to the bulkhead extensions, which in turn extend forward to



cover the transfer unit. Another bulkhead separates the engine and stowage compartments. The front of the hull slopes downward at the top and upward at the bottom to form a V. The sides of the hull slope inward at the bottom.

(3) Seats for the driver and assistant driver are mounted in the front of the hull. These seats have both an up-and-down and fore-and-aft adjustment (par. 11). Protective pads for driver and assistant driver are provided around the final drive propeller shafts, at the sides of the controlled differential and on the periscope head rests.

(4) The various stowage items carried in the hull are mounted in sheet metal containers which are bolted or latched to the hull floor and side walls. Ammunition stowage is provided in tubes under the gun mount platform, and in ammunition boxes carried on floor in rear compartment.

b. DATA. For detailed data on the hull refer to paragraph 4g.

## 155. Sealing Hull Parts

a. GENERAL. Joint-sealing compound should be applied to detachable hull parts when they are assembled to the vehicle to prevent water, dust, or fine sand from seeping through the joints and entering the hull.

b. PARTS TO BE SEALED. (1) Differential opening cover.

(2) Final drive housings.

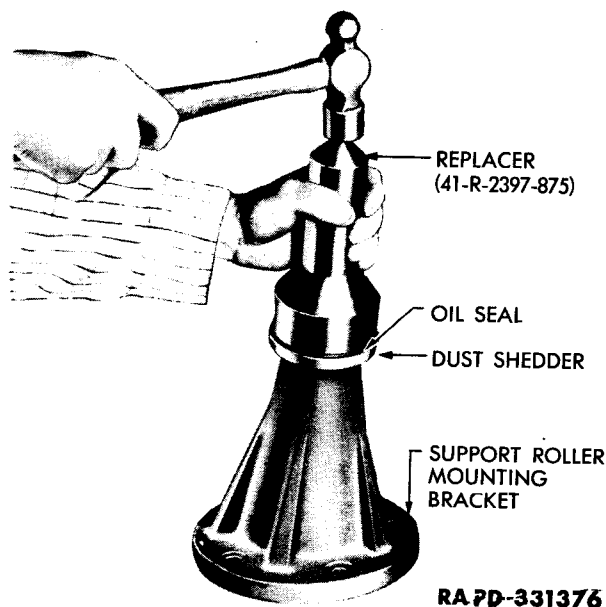


Figure 144. Installing track roller grease seal.

*c.* **HANDLING.** (1) Any cylinder containing gas under high pressure is as dangerous as a loaded shell. The extinguisher cylinders should never be dropped, stuck, handled roughly, or exposed to unnecessary heat.

(2) Red safety blow-off seal on valve head indicates whether cylinder has been discharged due to high temperature. Seal should be examined regularly; if it is missing, the cylinder should be replaced.

## **PART FOUR**

### **AUXILIARY EQUIPMENT**

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#### **Section XXXV. GENERAL**

##### **168. Scope**

Part Four contains information for the guidance of personnel responsible for operation of this equipment. It contains only the information necessary to using personnel to properly identify, connect, and protect such auxiliary equipment while being used or transported with the main equipment. Detailed instructions on this equipment are contained in separate technical manuals.

#### **Section XXXVI. ARMAMENT**

##### **169. Scope**

Section VII contains information required by the using arms to identify and operate the 155-mm. howitzer M1 in the 155-mm. howitzer mount M14. For preventive maintenance, malfunctions and corrections, disassembly, assembly, and general maintenance of the 155-mm. howitzer, refer to TM 9-331. For lubrication instructions, refer to section XIII of this manual.

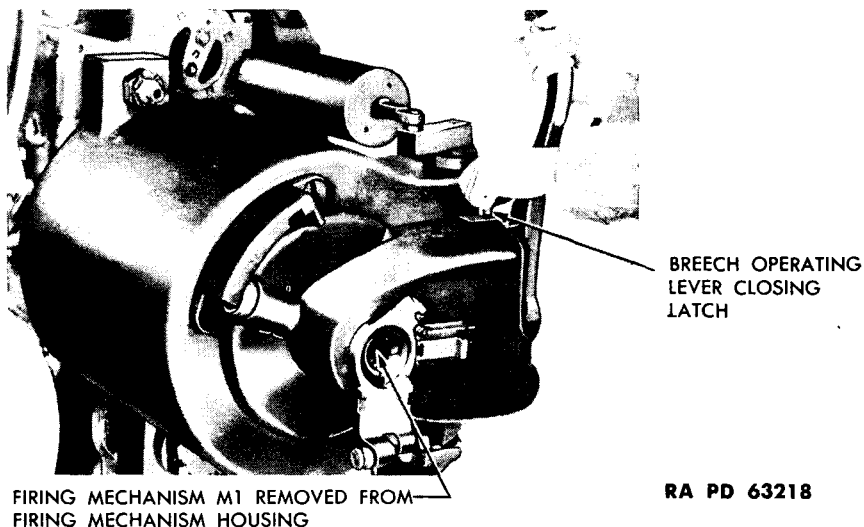
##### **170. Characteristics**

*a.* The armament of the 155-mm. howitzer motor carriage M41 is employed against emplaced battery and other ground objectives. The 155-mm. howitzer mount M14 for the weapon is located in the fighting compartment at the rear of the howitzer motor carriage (figs. 1, 2, 150, and 151).

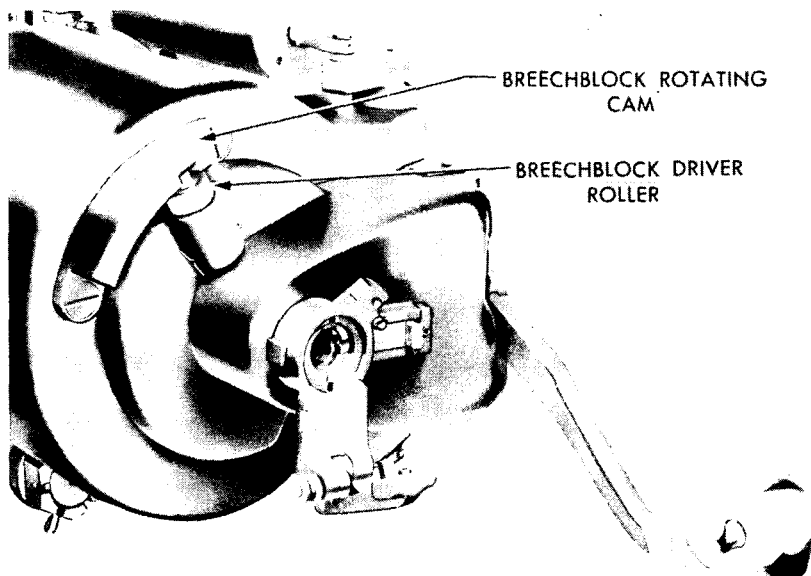
*b.* The 155-mm. howitzer M1 is a medium-barreled weapon using separate-loading ammunition. It is equipped with a manually operated breech mechanism and a percussion-type firing mechanism. The howitzer has a range movement in elevation of  $-5^{\circ}$  to  $+45^{\circ}$  and a traverse range of  $37^{\circ}$ , right  $20^{\circ}$ , and left  $17^{\circ}$ . It is equipped with recoil mechanism M6B1 of the variable recoil, hydropneumatic type. The length of recoil varies from 60 inches at  $0^{\circ}$  to  $25^{\circ}$  elevation to 41 inches at  $40^{\circ}$  to  $65^{\circ}$  elevation. Elevation and depression of the muzzle-heavy weapon is assisted by spring-type equilibrators.

### 173. Inspection Before Firing

a. Prior to firing, inspect the bore and breech to see that no dirt or foreign matter has accumulated. If there is foreign matter in the bore, clean the bore thoroughly and wipe it dry. Normally, the bore should be wiped or cleaned with rifle bore cleaner to remove the coating applied after the previous firing.



*Figure 153. Releasing breech operating lever closing latch.*



*Figure 154. Unsealing breech.*

b. Check the replenisher and recuperator to make certain that there is sufficient oil in the recoil and recuperator cylinders. Refer to TM 9-331.

c. Inspect to see that there is no leakage of oil, that the bearing surface of the howitzer tube is well lubricated, and that the piston rod nuts are properly tightened.

d. For bore-sighting weapon, refer to paragraph 182.

#### 174. To Traverse

The traversing handwheel is located on the left side of the carriage, ahead of the elevating handwheel (fig. 156). One complete turn of

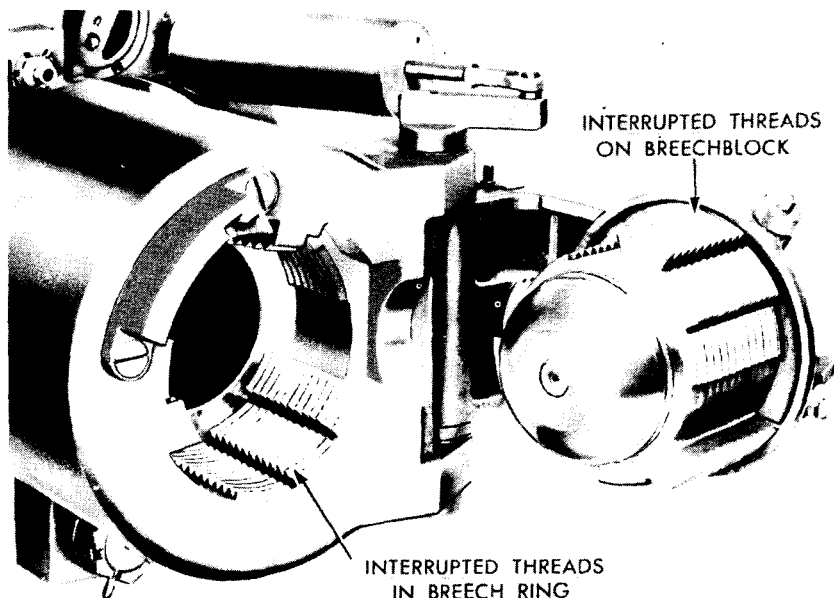


Figure 155. Breech mechanism open.

the handwheel in a clockwise direction traverses the carriage to the right approximately 10.3 mils (34.7 minutes). The range of traverse is 37° or 17° to the left and 20° to the right of midposition. Approximately 64 turns of the handwheel are required to traverse the mount from one side to the other of its range of traverse.

#### 175. To Elevate

The elevating handwheel is located at the left rear of the carriage in back of the traversing handwheel (fig. 156). One complete turn of the handwheel in a clockwise direction elevates the weapon approximately 10 mils (33 minutes). The range of elevation is 1,156 mils (65°). Approximately 78 turns of the handwheel are required to elevate the weapon from 0° to 65°.

(8) *Load propelling charge.* Place the charge in the chamber with the igniter end to the rear, and push it in until the base of the charge is flush with the rear end of the chamber. The igniter pad must come directly in front of the vent when the breech is closed to insure ignition of the charge.

*Note.* To insure intransmission of the flash from the primer to the charge, the obturator spindlehead should come in contact with the base of the charge when the breech is closed, must push the charge forward to its final position, and must remain in contact with it.

c. **TO CLOSE BREECH.** Swing the operating handle lever in a horizontal arc to the left. When the breechblock driver roller enters the breechblock rotating cam, raise the operating handle lever upward and forward until the operating handle latch latches the lever.



*Figure 157. Inserting primer.*

## **177. To Fire**

a. Insert a percussion-type primer in the firing mechanism, M1 (fig. 157). The primer case is inserted into the primer holder by pressing the head of the case downward firmly against the firing pin guide so that the rim of the case slides under the edges of the slot in the primer holder. The primer is then held in position by the pressure of the firing spring.

b. In inserting the primer in the primer holder, the primer should be held in such a manner that no part of the hand is in front of the wad end of the primer. This precaution must be taken to avoid a severe burn in the case of premature discharge of the primer.

c. Should the primer be slightly oversize or the primer holder dirty, the primer will stick before it is properly seated. Force should not be exerted. Remove the primer and clean the primer holder, or insert another primer.

d. Insert the firing mechanism in the firing mechanism housing, taking care that the front end of the primer has entered the obturator spindle plug. Seat the mechanism by turning the firing mechanism

handle in a clockwise direction until it has contacted the firing mechanism block handle arm stop and has been latched. If the mechanism will not seat properly, the primer may be oversize, or its seat in the plug or in the primer holder may be dirty, or the breech may not be fully closed.

**Caution:** Make certain that the firing mechanism M1 is screwed home and is latched in position.

e. Attach the lanyard. Draw the percussion hammer lock pin to the left and out of the path of the hammer, turning the percussion hammer lock pin knob to place the pin in locked-out position.

f. Grasp the handle of the 4-foot lanyard (21-L-123-725) with the right hand, and without raising the hand, pull with a quick, strong pull (not a jerk) prolonged sufficiently to ensure the percussion hammer hitting the firing pin. The lanyard will be pulled from a position as near the rear of the piece as is convenient, and sufficiently out of the line of recoil to ensure safety.

g. If the long, 50-foot lanyard (21-L-106) is used, it will be attached immediately before, and detached immediately after, the round is fired.

## 178. To Unload

a. **SERVICE ROUNDS.** Whenever possible, live, fuzzed projectiles are to be unloaded from the piece by being fired out of the weapon. Where conditions do not permit the firing of the weapon, the round is to be removed with the cleaning and unloading rammer head M7 (C57112). Depress the weapon to zero elevation, and with the loading tray in position in the breech, insert the rammer head into muzzle of howitzer. Then ram the round out of the howitzer onto the loading tray. This operation must be done by or under the personal supervision of the battery commander.

b. **DUMMY PROJECTILE.** To unload the dummy projectile, lower the weapon to zero elevation. Pull out the dummy charge and, with the loading tray in place, remove the projectile with the hook-type extractor (72-1-5, type C). Insert the extractor in the base of the projectile, hook it against the shoulder of the recess, and pull the projectile out of the howitzer onto the loading tray. If the extractor is not available, the projectile may be removed by use of the cleaning and unloading rammer head, M7. This operation is performed from the muzzle end of the weapon.

c. **TO REMOVE A FUZE FROM A SHELL.** If, for any reason, a projectile which has been fuzeed is not to be fired, the fuze will be removed. Reset the fuze to "SAFE," if so designed. Start the unscrewing operation with fuze wrench M7A1; complete the unscrewing of the fuze by hand.

**Caution:** If the adapter starts to unscrew with fuze, the unscrewing operation must be stopped at once and the shell disposed of as directed by the officer in charge.

This operation is permissible in indirect fire.) The howitzer is now laid in elevation. When a higher degree of accuracy is required, continue the operation by placing an accurately set gunner's quadrant on the quadrant seat and rotating the howitzer elevating handwheel to center the level bubble in the quadrant.

*h.* To aim the howitzer for direct fire, proceed as follows: Set the elevation knob on the panoramic telescope to zero elevation by matching the coarse zero graduation and the micrometer zero graduation against their indexes. Set the azimuth scale, micrometer index, and

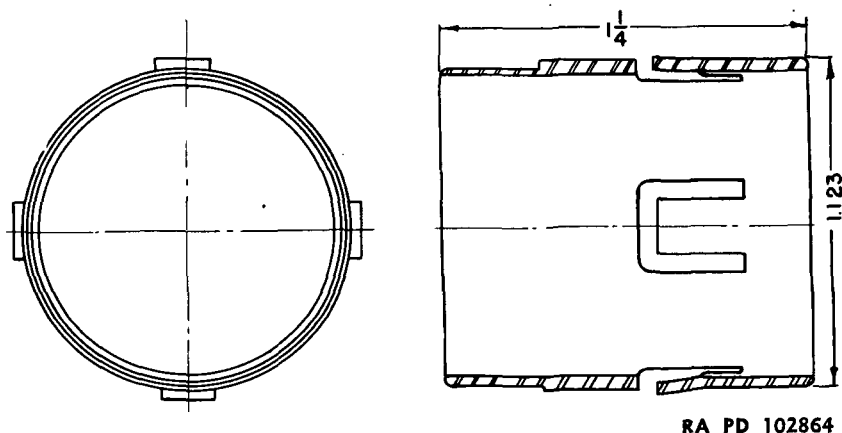


Figure 165. Reticle pattern for panoramic telescope M12A6.

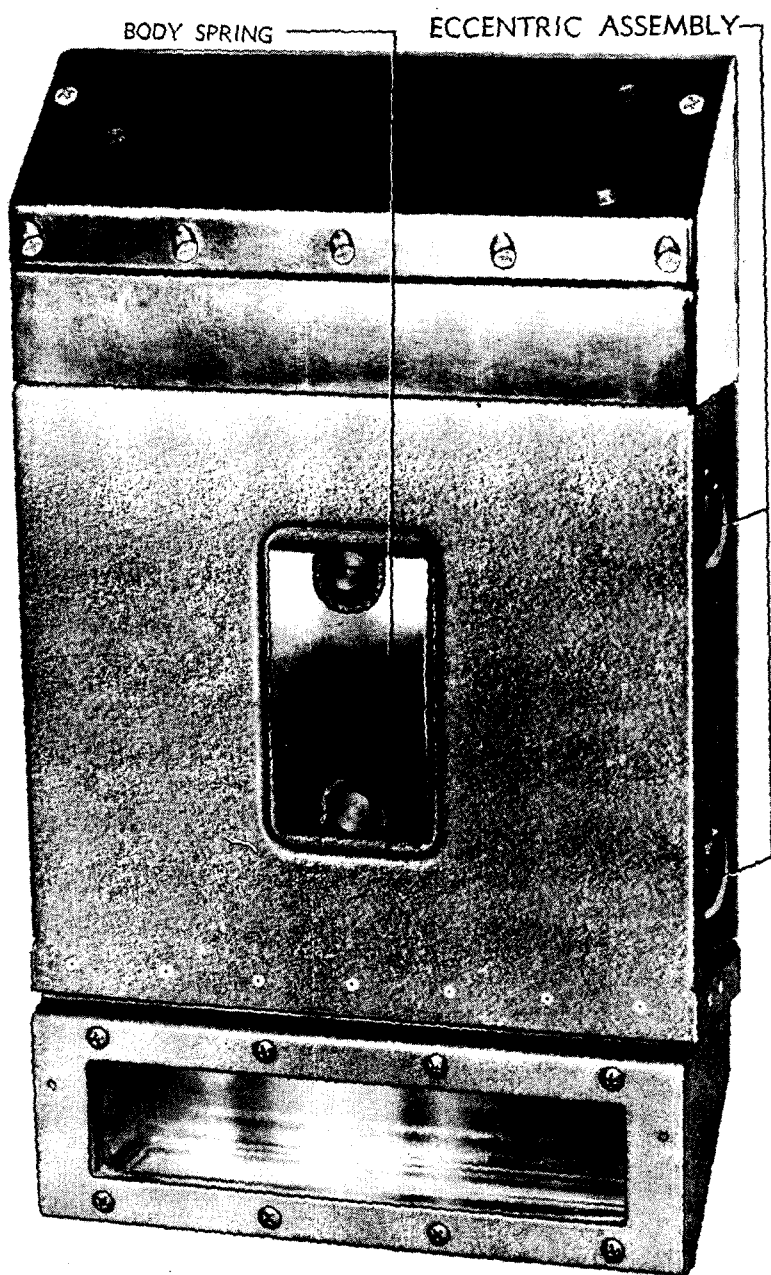
micrometer to zero. Set the elevation scale and micrometer on the telescope mount to zero. Cross-level the mount and keep it cross-leveled during the remaining operations. Using the howitzer traversing and elevating handwheels, bring the target to the required range and deflection on the telescope reticle.

## 182. Bore Sighting

*a.* The purpose of the bore-sighting operation is to test the alignment of the sighting equipment for parallelism with the bore of the howitzer. For expediency, it may be performed by sighting on a well-defined object at least 1,500 yards distant.

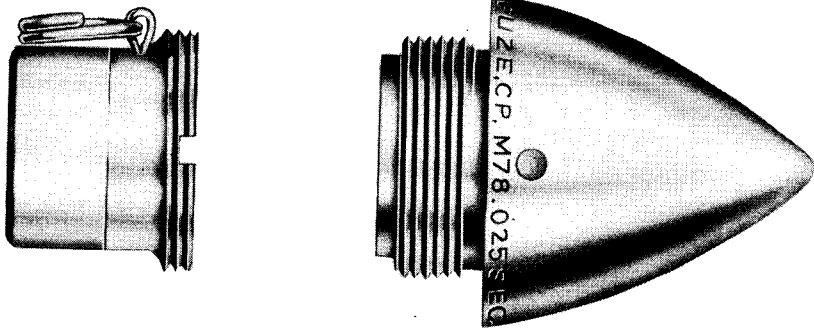
*b.* Open the breech of the howitzer, place bore sights in the tube, and, while looking through the tube, aline the howitzer on the distant object. With the telescope in position in the mount (azimuth scale set at zero), observe through the eyepiece and note the position of the cross lines with respect to the distant object or aiming point. If they do not coincide with the distant object or aiming point, move the line of sight, as follows: Loosen the headless lock screws in the telescope socket and adjust the tangent screws until coincidence is obtained; tighten the headless lock screws.





RA PD 55456

*Figure 166. Periscope M6.*



RA PD 97699

Figure 176. CP fuze, M78.

with S below it, and time graduations to 75 seconds with 0.5-second intervals, are stamped on the body. The graduations run counterclockwise, viewed from the point of the fuze. Two setting grooves, one each on the lower cap and body, are provided for setting the fuze. A safety feature incorporated in the fuze is designed to prevent functioning should the fuze be set for 3 seconds or less. As shipped, the fuze is set "safe." That is, the set line in the lower cap is in alignment with the safety line S in the body. A pull wire is fitted to the fuze to secure the firing pin prior to firing. A cotter pin with pull ring is assembled to the booster to prevent accidental movement of the detonator during shipment. The booster is assembled to the fuze at the time of manufacture and handled thereafter as a single unit with the fuze, in shipment and assembly to the projectile. The cotter pin is to be withdrawn just prior to assembling the fuze with booster to the shell.

(2) *Preparation for firing.* To fuze the projectile proceed as follows:

- (a) Remove the eye bolt lifting plug from the projectile.
  - (b) Inspect the fuze cavity and threads. They should be free of foreign matter which would interfere with the proper assembly of the fuze.
  - (c) Remove the cotter pin from the booster.
  - (d) Screw the fuze with booster into the projectile by hand. Tighten with the fuze wrench.
  - (e) Remove the safety pull wire. This can be done readily by pulling the end of the wire from the hole in the lower cap and sliding the wire off the end of the fuze.
  - (f) Set fuze by means of fuze setter, the lower cap being turned in a counterclockwise direction as viewed from the point of the fuze. The torque required to set the fuze is between 80 and 100 inch-pounds.
- e. CP FUZE M78 (T105). (1) *Description.* The M78 (T105)

concrete-piercing fuze and M25 (T1E1) booster (fig. 176) are used to convert the HE shell M101 or Mk3A1 into a concrete-piercing shell. In this case, both the fuze and booster are shipped in the same container, but as separate components. The fuze is a solid hardened steel nose plug which contains a detonator assembly in its base. It is shorter and heavier than the fuzes described above. The fuze M78 is fitted with either a 0.025-second delay or nondelay element; the amount of delay is as indicated by the stamping on the body of the fuze.

*Note.* All fuzes T105 were equipped with 0.05-second delay detonator assemblies during the early development of this fuze.

Nondelay fuzes are designed primarily for spotting purposes. Fuzes with 0.025-second delay elements are designed to be used for firing for effect. The booster M25 (T1E1) is a modified M21A2 booster containing approximately three external threads rather than six. A cotter pin with pull ring, which is located in the booster body, must be removed prior to assembly of the booster to the shell. This booster is intended for use only with CP fuze, M78 (T105).

(2) *Preparation for firing.* After removal of lifting plug from projectile, proceed as follows:

(a) Remove the safety pin from the M25 booster and screw the booster into the booster cavity in the shell. Tighten booster firmly with the booster end of the wrench (fig. 177) which is issued with the M78 fuzes.

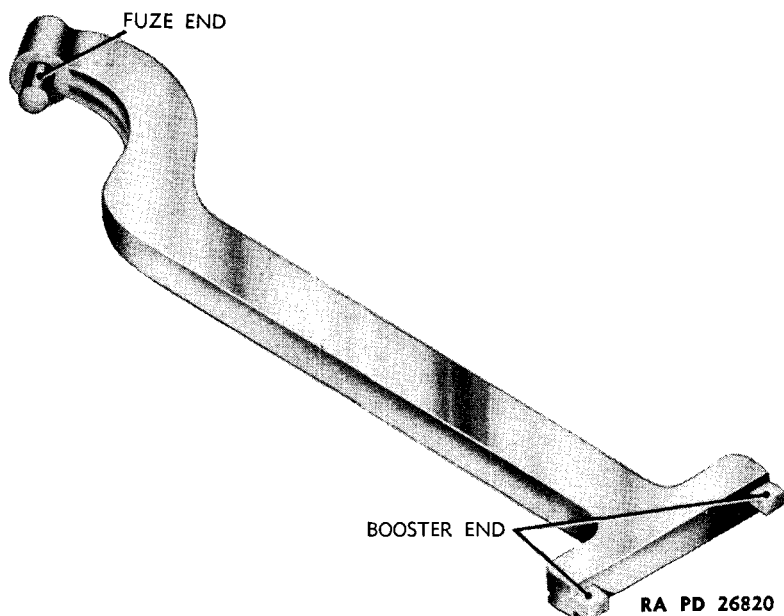


Figure 177. Wrench for M78 fuze.

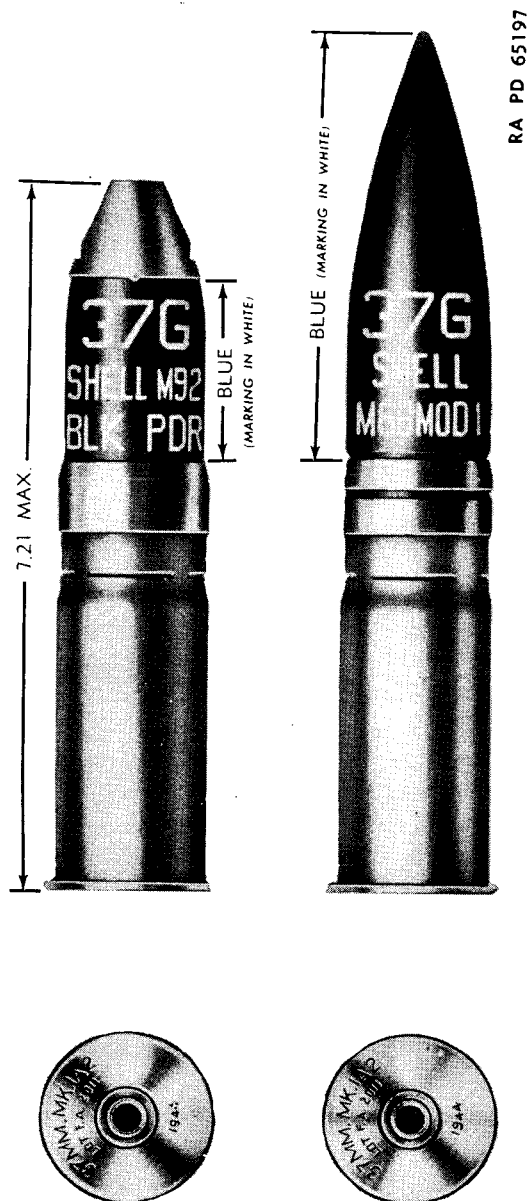


Figure 178. Subcaliber ammunition.

(b) Screw the M78 fuze into the fuze cavity and tighten securely with fuze end of wrench. Be sure that the fuze shoulder seats firmly against the nose of the shell; there should be no space between shoulder of fuze and shell. Do not stake fuze to the shell.

## **187. Subcaliber Ammunition**

The rounds listed below and illustrated in figure 178 are authorized for use for subcaliber purposes.

SHELL, fixed, practice, M63 Mod 1, for 37-mm subcaliber guns, M12, M13, M14, M16, and M1916.

SHELL, fixed, practice, M92, for 37-mm subcaliber guns, M12, M13, M14, M16, and M1917.

## **Section XL. RADIO AND INTERPHONE EQUIPMENT**

### **188. Radio and Interphone Equipment**

a. GENERAL. Howitzer motor carriage M41 (155-mm. howitzer) is equipped with radio sets SCR-610 or SCR-619 and interphone equipment RC-99. These radio sets and the interphone equipment operate off of the 24-volt vehicular electrical system, except for the SCR-610 when equipped with power unit PE-117. The power connections for the interphone equipment are made in the radio terminal box mounted in the hull ceiling. Radio sets SCR-610 and SCR-619 are frequency modulated and voice-operated only. Signal Corps drawing and installation instructions have been prepared for radio and interphone installations referred to above. If needed, copies may be obtained through organizational signal officer.

b. RADIO SET SCR-610 (figs. 179 and 180). Major components of this set consist of a radio receiver and transmitter BC-659 and plate supply unit PE-117 or PE-120 mounted on mounting base FT-250.

c. RADIO SET SCR-619 (figs. 181 and 182). Major components of this set consist of a radio receiver and transmitter BC-1335, battery charger PE-219 and battery boxes CH-291 mounted on mounting base FT-506.

d. INTERPHONE EQUIPMENT RC-99. Components of this equipment are interphone amplifier BC-667 (figs. 183 and 184) and control boxes BC-606 and BC-739 (figs. 185 and 186). Interphone amplifier is located on vehicle front plate directly in front of co-driver. Control boxes are provided for the driver, assistant driver, gunner, and commander.

### **189. Mountings**

a. MOUNTING BASE FT-250 (fig. 180). This mounting base is used with radio set SCR-610 described in paragraph 188. Base is made

up of two sections which are connected together through four rubber grommets. Lower section is fastened to vehicle brackets with four cap screws. Plate supply unit fastens to top portion of mounting base by use of four snap fasteners. Transmitter-receiver is located on top of plate supply unit and is fastened thereon by use of snap fasteners.

b. MOUNTING BASE FT-506 (fig. 182). This mounting base is used with radio set SCR-619 described in paragraph 189. Base is made up of two sections which are connected together through four rubber grommets. Lower section is fastened to vehicle brackets with four cap screws. Radio components are fastened to top portion of mounting base by use of snap fasteners.

## 190. Antenna

a. MAST BASE AB-15/GR (fig. 187). This base is equipped with a flexible section immediately above the porcelain insulator. This base is secured to its mounting bracket by a clamping action of the porcelain insulator and a hexagonal nut on lower end of base. This base is used with radio sets SCR-610 and SCR-619.

b. MAST SECTION. The frequency modulated sets use three mast

RECEIVER—TRANSMITTER BC-659

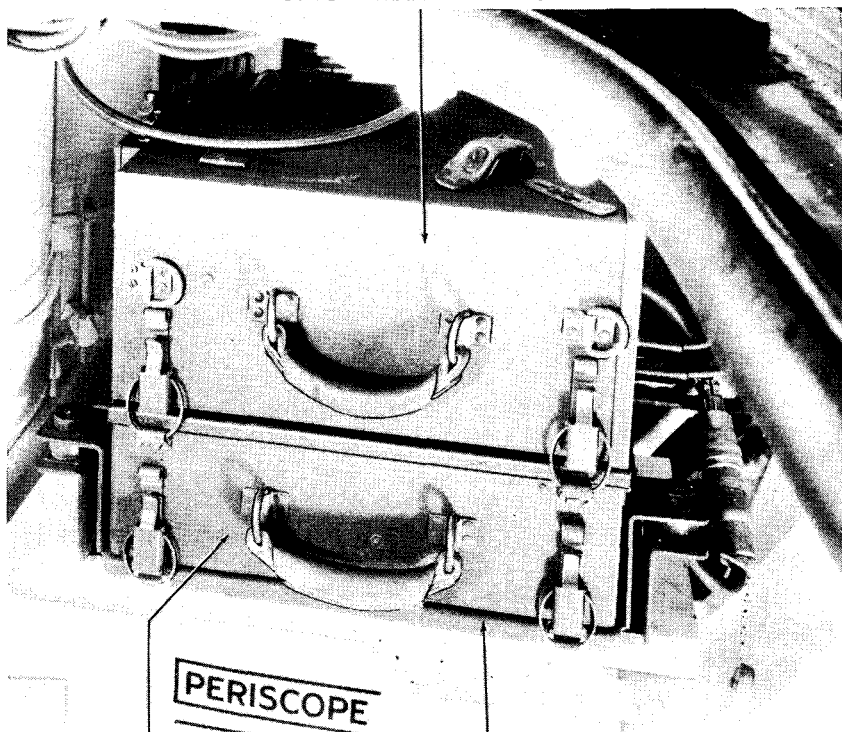


PLATE SUPPLY UNIT PE-120

MOUNTING BASE FT-250

RA PD. 331951

Figure 179. Radio set SCR-610—located between driver and assistant driver.

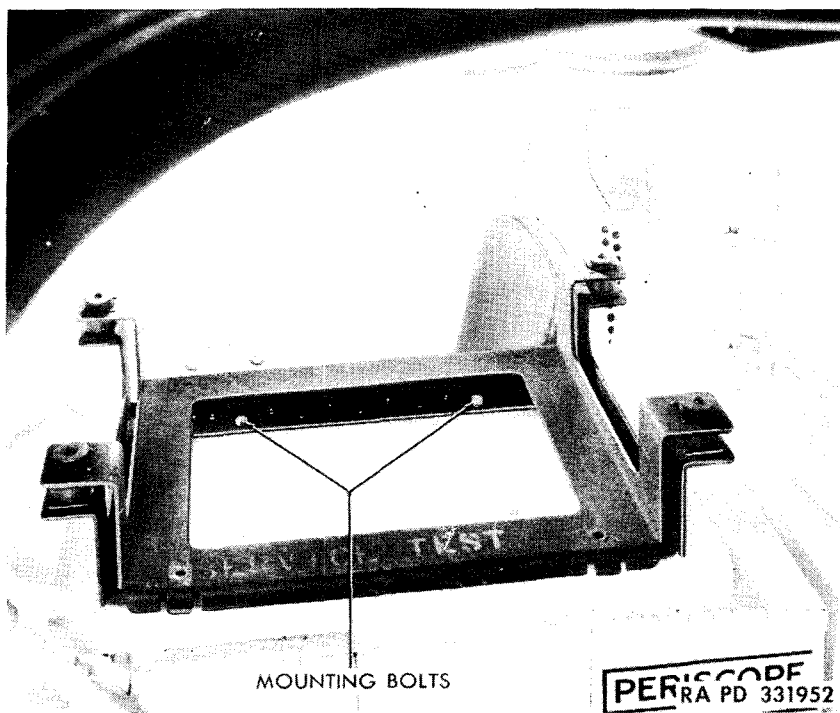


Figure 180. Mounting base FT-250—part of radio set SCR-610.

sections, numbers MS-116, 117 and 118. Sections are made of high tensile steel and are secured together so that ends with like color enamel are joining. Body of the mast bears type number. Clamps are provided to keep the mast sections from loosening while in use. These sections and spare sections are stowed in roll bag BC-56 when not in use.

## 191. Inspections

a. ANTENNA. (1) *Mast sections.* Inspect antenna mast sections to be sure that they are securely screwed and clamped together and are not damaged.

(2) *Mast base.* See that mast base is secured to its bracket or mounting surfaces and stands in a vertical position and that insulator is not cracked or chipped.

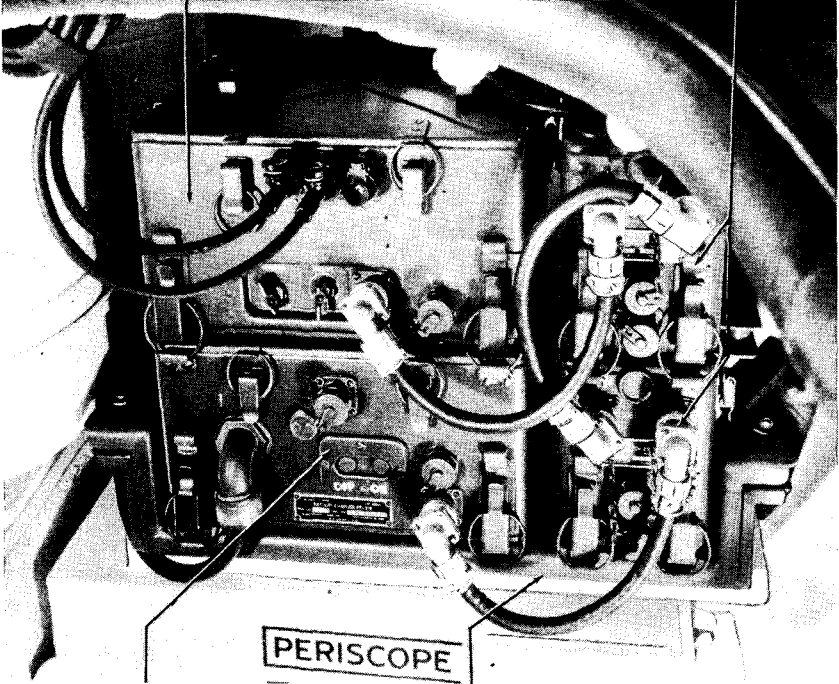
(3) *Leads to set.* Check leads to set and be sure that there is no interference that may damage cords and that any stand-off insulators are not cracked or chipped.

b. MOUNTINGS. (1) *Snap fasteners.* Be sure that radio components are securely fastened onto mounting base.

(2) *Lock washers.* When reinstalling radio or interphone equipment, make sure that all toothed lock washers are replaced in locations where they were originally used.

RECEIVER—TRANSMITTER BC-1335

BATTERY BOX CH-291

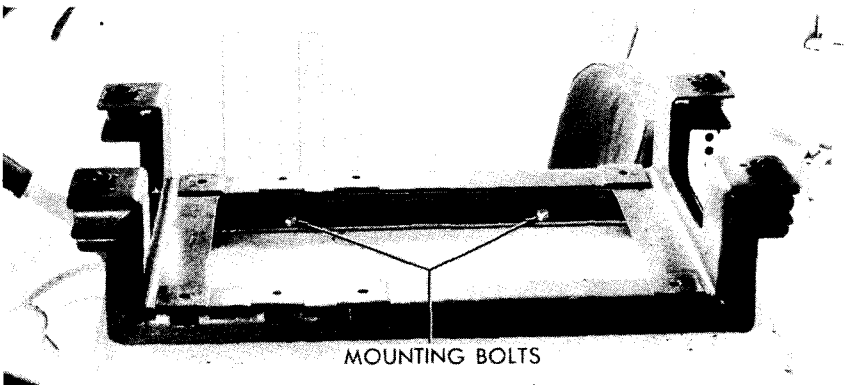


BATTERY CHARGER PE-219

MOUNTING BASE FT-506

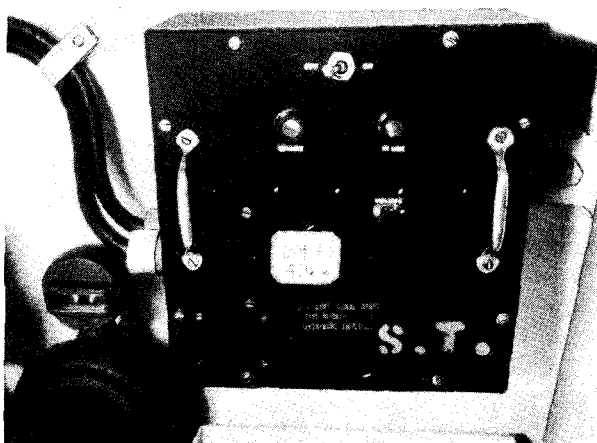
RA PD 331953

*Figure 181. Radio set SCR-619—located between driver and assistant driver*

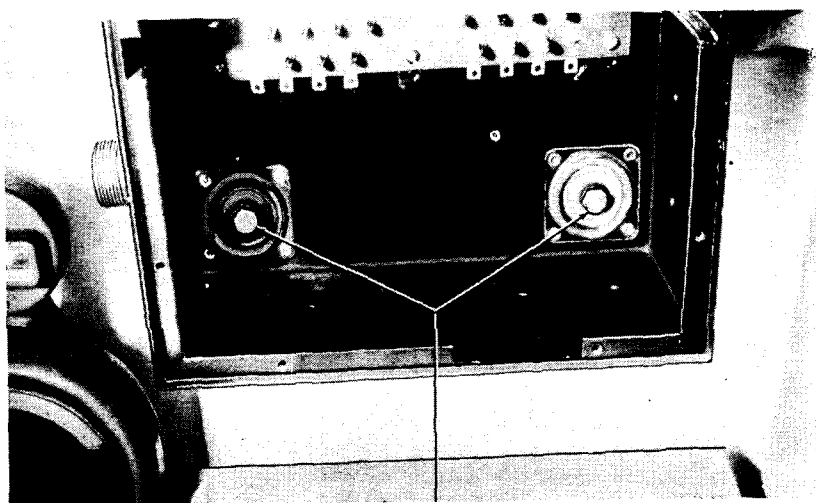


*Figure 182. Mounting base FT-506—part of radio set SCR-619.*





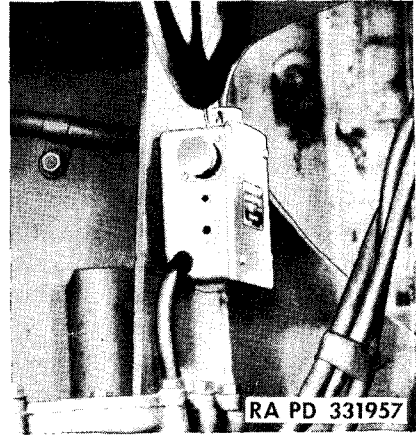
*Figure 183. Interphone amplifier BC-667—part of interphone equipment RC-99*



MOUNTING BOLTS

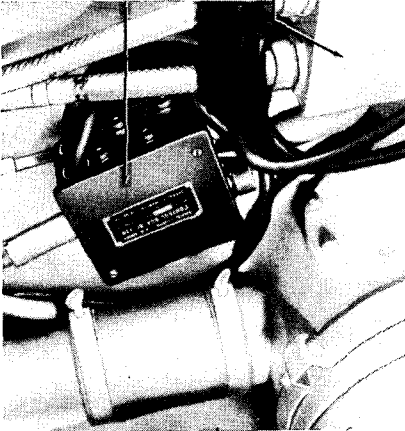
RA PD 331956

*Figure 184. Interphone amplifier BC-667—front panel removed.*

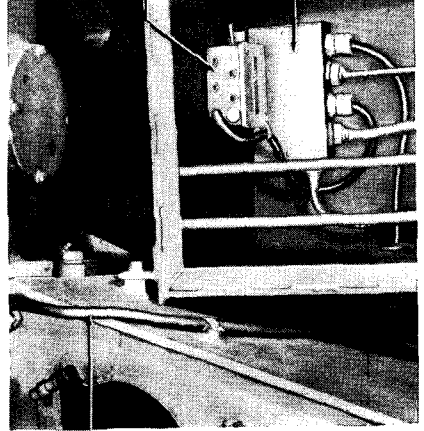


*Figure 185. Interphone control box BC-606-H.*

RADIO TERMINAL BOX  
CONTROL BOX BC-739-A



CONTROL BOX BC-739-A  
RADIO TERMINAL BOX



CABLE TO GUNNER'S INTERPHONE CONTROL BOX BC-606-H

*Figure 186. Control box BC-739-A.*

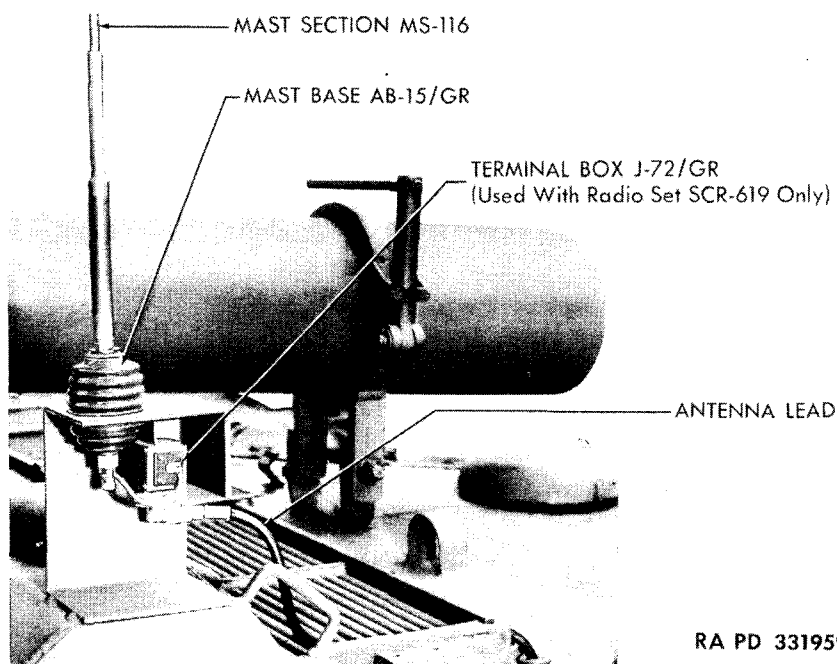
(3) *Shock mounts.* Inspect mounting screws to see that they are tight and that shock mountings are in good condition. Rock set and interphone amplifier to determine if they bump any other equipment, and observe whether shock absorbers are deteriorated and permit excessive movement.

c. **CORDS AND CONNECTIONS.** Inspect all cords which connect radio or interphone equipment to see that they are not damaged; make sure they are properly secured in clips. Report any damage to proper authority.

d. **MICROPHONES AND HEADSETS.** Handle microphones and headsets with care to see that they are hung on hooks provided for this purpose when not in use. Be sure that cords are not twisted or knotted to prevent movement of wearer. Inspect jack plugs on microphones and headsets to see that they are not damaged.

e. **RADIO TERMINAL BOX** (fig. 186). Remove cover and check tightness of all terminal nuts. Tighten nuts, if necessary, to prevent any movement of wire on terminal stud; by doing this, any possibility of radio interference from this source is eliminated. Also check presence and fastening of condensers in terminal box.

f. **COVERS.** Be sure that cover for protection of radio set is available in vehicle and that cover is installed when equipment is not in use. See that all fasteners and zippers are in good condition. Cover BG-153 is used with radio set SCR-610.



RA PD 331959

Figure 187. Antenna.

## 192. Precautions

*a. ANTENNA.* Tie antenna down securely when vehicle is in motion and radio is not in use to prevent damage to antenna. Be sure antenna is vertical and not touching anything when radio is in use.

*b. RADIO.* (1) Keep radio covered when vehicle is not in use to prevent dust and moisture from entering set. Keep all cover plates closed and securely fastened.

(2) Turn off all radio and interphone switches when not in use. Do not turn off master battery switch with radio and interphone on.

(3) Do not store equipment behind radio where it can prevent movement on mountings or damage to connections.

*c. BATTERIES AND CHARGING SYSTEM* (figs. 47 and 49). (1) Be sure batteries are charged at all times to insure satisfactory operation of set (par. 46). Low batteries will cause set to be weak and unstable resulting in poor reception, and may make it difficult to start vehicle. Excessive charging rate may cause damage to radio set and interphone amplifier.

(2) See that all battery cables and terminals are in good condition and tight.

# APPENDIX I

## SHIPMENT AND LIMITED STORAGE

---

### 1. General Instructions

Preparation for domestic shipment of vehicle is the same as preparation for limited storage. Preparation for shipment by rail includes instructions for loading and unloading vehicle, blocking necessary to secure vehicle on freight cars, clearance, weight, and other information necessary to prepare vehicle properly for rail shipment. For more detailed information and for preparation for indefinite storage, refer to AR 850-18 and FM 9-25.

### 2. Preparation for Limited Storage or Domestic Shipment

*a.* A vehicle to be prepared for limited storage or domestic shipment is one temporarily out of service for less than 30 days, or a vehicle that must be ready for operation on call. If vehicle is to be indefinitely stored after shipment by rail, it will be prepared for such storage at its destination.

*b.* If vehicle is to be placed in limited storage or shipped domestically, take the following precautions:

(1) *Lubrication.* Completely lubricate entire vehicle including armament, except engine (pars. 32 and 33). For preparation of engine, see subparagraph (10) below.

(2) *Batteries.* Check batteries and terminals for corrosion and, if necessary, clean and thoroughly service batteries (par. 84).

(3) *Road test.* After battery check and lubrication services, make a road test of at least 5 miles to check on general condition of vehicle. Correct any defects noted in vehicle operation before vehicle is stored or shipped, or note on a tag attached to steering levers, stating repairs needed or describing condition present. A written report of these items will then be made to the officer in charge.

(4) *Fuel in tanks.* It is not necessary to remove fuel from tanks during temporary storage or shipment within the United States, nor to label tanks under Interstate Commerce Commission Regulations. Leave fuel in tanks except when storing in locations where fire ordinances or other local regulations require removal of all gasoline before storage. If vehicles are to be maintained ready for operation on call in excess of 30 days, take the following precautions against gum formation:

(*a*) Fuel system must be free from accumulated gum. Unless vehicle is entering its first storage and has never been issued for use, inspect and clean fuel pump, carburetor accelerator pump plunger,

venturi tube, choke and throttle valves, float mechanism, fuel lines, fuel tanks, fuel filters, fuel shut-off valves, and screens.

(b) If gum is present in the above parts, it can best be removed by benzol, acetone, alcohol, or a mixture of equal parts of these solvents. Deposited gum is not readily soluble in fresh gasoline. When gum has dried, it may be necessary to use mechanical means to remove it.

(c) Parts which cannot be thoroughly cleaned and freed from gum deposit without damage should be replaced.

(d) After cleaning and reassembly, fill fuel tanks half full with fresh gasoline which has not been in storage very long.

(e) Add two containers (8 ounces) of gum preventive compound to each fuel tank.

(f) Fill fuel tanks to capacity and operate vehicle for at least 5 minutes.

(5) *Breech mechanism.* When possible, partially disassemble breech mechanism, clean with dry-cleaning solvent, and dip or brush interior parts with rust preventive compound (light). Assemble breech mechanism. Apply a coating of rust preventive compound (light) to all exterior portions of the breech.

(6) *Howitzer tube.* Clean bore with dry-cleaning solvent and thoroughly dry. Swab bore with rust preventive compound (light).

(7) *Sealing howitzer.* Seal the muzzle and breech with two layers of grease-proof wrapping paper and one of Kraft waterproof wrapping paper. Apply nonhygroscopic adhesive tape over paper, completely sealing the openings. Apply rust preventive compound (thin film) over the tape as a sealer. If greaseproof wrapper is not available, use canvas or burlap impregnated with rust preventive compound (thin film).

(8) *Covers.* Install muzzle and breech covers supplied with material.

(9) *Exterior of vehicle.* If time and facilities permit, remove rust appearing on any part of the vehicle exterior with flint paper. Repaint painted surfaces whenever necessary to protect wood or metal. Coat exposed polished metal surfaces susceptible to rust, with rust preventive compound (light). Close all doors, hatches, vision slots, and other openings firmly. Make sure tarpaulins are in place and firmly secured. Leave rubber floor mats, when provided, in an unrolled position on the floor, not rolled or curled up. Equipment such as pioneer tools, track tools, and fire extinguishers will remain in place on the vehicle. For treatment of small arms carried on or within the vehicle, refer to pertinent technical manuals.

(10) *Engine.* (a) Remove spark plugs and spray into tops of cylinders with preservative engine oil (PE 30) while slowly rotating engine. Replace spark plugs.

(b) If spark plugs cannot be removed, spray preservative oil into

air intake with engine running at a fast idle until smoke comes from exhaust pipe.

**Caution:** Preservative oil must never be poured through carburetor.

After spraying preservative oil into air intake, shut off engine and allow to cool for about 15 minutes. Start engine and again spray preservative oil into air intake for several minutes only. Second spraying is necessary in order to coat exhaust valves. Do not run engine for more than several minutes as exhaust valves will become so hot that preservative oil will not adhere properly. Perform this treatment when further running of the engine is not necessary.

(c) If it becomes necessary to run engine after treatment, it should not be operated at over 1,600 revolutions per minute. Hold operation to a minimum and spray cylinders again after operation.

(11) *Inspection.* Make a systematic inspection just before shipment or limited storage to insure that all the above steps have been covered, and that the vehicle is ready for operation on call. Make a list of all missing or damaged items and attach it to the steering levers. Refer to Before-operation Service (par. 36).

(12) *Brakes.* Release brakes and chock tracks.

c. **INSPECTIONS IN LIMITED STORAGE.** When vehicle is placed in limited storage, inspect batteries weekly. If water is added to batteries when freezing weather is anticipated, recharge batteries with a portable charger or remove them for charging.

**Caution:** Do not attempt to recharge batteries by running auxiliary generator.

Remove any rust from vehicle with flint paper and touch up with paint or light preservative compound if necessary. Make a weekly, visual inspection of armament during storage to determine general condition. If corrosion is found at any parts, remove rust spots and treat with prescribed preservative.

*Note.* No rust preventive compound has been developed that will stop corrosion indefinitely.

### **3. Loading and Blocking for Rail Shipment**

a. **PREPARATION.** In addition to the preparation described in paragraph 194, when ordnance vehicles are prepared for domestic shipment take the following steps:

(1) *Exterior.* Cover the body of the vehicle with the canvas cover supplied as an accessory, or available for use during rail shipment.

(2) *Batteries.* Disconnect the batteries to prevent their discharge by vandalism or accident. This may be accomplished by disconnecting the positive lead, taping the end of the lead, and tying it back away from the batteries.

(3) *Transmission.* Move transmission selector lever either to **DRIVE** or **LOW** position to move the linkage away from the position stops, and to prevent the lever from being jarred out of adjustment.

(4) *Marking cars.* All cars containing ordnance vehicles must be placarded "DO NOT HUMP."

(5) *Types of cars.* Ordnance vehicles may be shipped on flat cars, end-door box cars, side-door box cars, or drop-end gondola cars, whichever type is most convenient.

b. **FACILITIES FOR LOADING.** Whenever possible, load and unload vehicles from open cars under their own power, using permanent end ramps and spanning platforms. Movement from one flat car to another along the length of the train is made possible by cross-over plates or spanning platforms. If no permanent end ramp is available, an improvised ramp can be made from railroad ties. Vehicles may be loaded in gondola cars without drop ends by using a crane. In case of shipment in side-door box cars, use a dolly-type jack to warp the vehicles into position within the car.

c. **BRAKES.** Locate the vehicles on the car in such a manner as to prevent the car from carrying an unbalanced load. After the vehicle has been placed in position with a brake wheel clearance of at least 6 inches (*A*, fig. 188), apply brakes and place the transmission in low gear.

d. **SECURING VEHICLES.** In securing or blocking a vehicle, three motions, lengthwise, sidewise, and bouncing must be prevented. The following are approved methods of blocking and securing these vehicles on freight cars:

(1) *Method one.* Place four blocks (*B*, fig. 188), one to the front and one to the rear of each track. Nail the heel of each block to the car floor with five forty-penny nails. Toenail to the car floor, with two forty-penny nails, that portion of each block which is under the track. Locate two blocks (*C*, fig. 188) on each side of the vehicle on the outside of each track. Nail each block to the car floor with three forty-penny nails. These blocks may be located on the inside of the tracks if conditions warrant.

(2) *Method two.* Place two blocks (*F*, fig. 188), one to the front and one to the rear of the tracks. These blocks are to be at least as long as the over-all width of the vehicle at the car floor. Locate eight blocks (*G*, fig. 188) against the blocks (*F*, fig. 188) to the front and to the rear of each track. Nail the lower block to the floor with three forty-penny nails and the top block to the lower block with three forty-penny nails. Locate and secure blocks (*C*, fig. 188) as explained in subparagraph (1) above.

e. **SHIPPING DATA.**

Length, over-all-----	230 inches.
Width-----	112 inches.
Height-----	96 inches.
Area of car floor occupied per vehicle-----	179 square feet.
Volume occupied per vehicle-----	1,432 cubic feet.
Shipping weight per vehicle-----	40,500 pounds.



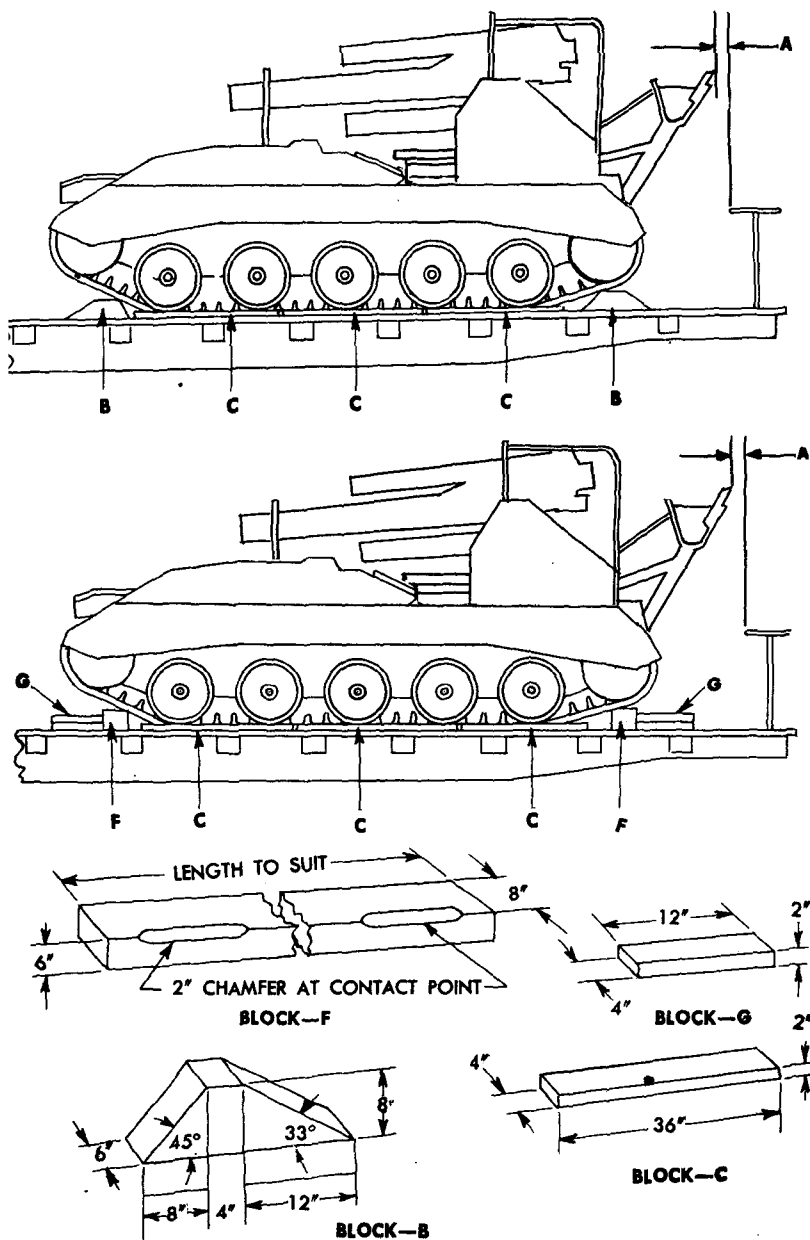


Figure 188. Blocking requirements for rail shipment.

# APPENDIX II

## REFERENCES

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### 1. Publication Indexes

The following publications indexes should be consulted frequently for latest changes to or revisions of the publications given in this list of references and for new publications relating to matériel covered in this manual:

- Introduction to Ordnance Supply Catalog    ORD 1.  
(explaining SNL system).
- Ordnance Publications for Supply Index    WD Cat. ORD 2.  
(index to SNL's).
- Ordnance major items and combinations, and    SB 9-1.  
pertinent publications (alphabetical listing  
of ordnance major items and combinations  
with publications pertaining thereto).
- List and index of War Department Publica-    FM 21-6.  
tions (listing FM's, MR's, MTP's, MWO's,  
RR's, SB's, TM's, TR's, T/O & E's, T/BA's,  
T/A's, TC's, WDLO's, WDTB's, firing  
tables and charts, forms, new AR's, changes  
and revisions, personnel classification tests,  
and pamphlets).
- List of Training Films, Film Strips and Film    FM 21-7.  
Bulletins (listing TF's, FS's, and FB's, by  
serial number and subject).
- Military Training Aids (listing graphic train-    FM 21-8.  
ing aids, models, devices, and displays).

### 2. Standard Nomenclature Lists

#### a. VEHICULAR.

- Carriage, motor, 155-mm howitzer, M41    ORD SNL G-236.\*  
(T64E1).

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\*See WD Catalog ORD 2 Index for published pamphlets of the Ordnance Supply Catalog.

*b. MAINTENANCE.*

Antifriction bearings and related items-----	ORD 5 SNL H-12
Cleaning, preserving, and lubrication materials, recoil fluids, special oils, and miscellaneous related items.	ORD 3 SNL K-1.
Elements, oil filter-----	ORD 5 SNL K-4.
Lubricating equipment, accessories and related dispensers.	ORD 5 SNL K-3.
Miscellaneous hardware-----	ORD 5 SNL H-2.
Soldering, brazing, and welding materials, gases, and related items.	ORD 3 SNL K-2.
Standard hardware-----	ORD 5 SNL H-1.
Tools, maintenance, for repair of motor vehicles:	
Tool-sets (special), motor vehicles-----	ORD 6 SNL G-27 (Sec. 1).
Tool-sets (common) specialists' and organizational.	ORD 6 SNL G-27 (Sec. 2).
Tools, maintenance, for repair of pack, light and medium field artillery; and armament of these calibers for airplane and combat vehicles.	ORD 6 SNL C-18.

*c. AMMUNITION.*

Ammunition, blank, for pack, light and medium field, tank, and antitank artillery.	ORD 11 SNL R-5.
Ammunition, fixed and semifixed, including subcaliber, for pack, light and medium field, tank, and antitank artillery, including complete round data.	ORD 11 SNL R-1.
Ammunition instruction material for pack, light and medium field, aircraft, tank, and antitank artillery.	ORD 11 SNL R-6.
Projectiles and propelling charges, separate loading, for medium field artillery, including complete round data.	ORD 11 SNL R-2.
Service fuzes and primers for pack, light and medium field, aircraft, tank, and antitank artillery.	ORD 11 SNL R-3.

*d. ARMAMENT.*

Howitzer, 155-mm, M1; and mount, howitzer, 155-mm, M14 (T19).	ORD (*) SNL C-39.
Gun, submachine, cal. .45, M3-----	ORD (*) SNL A-58.
Carbine, cal. .30, M1-----	ORD (*) SNL B-28.

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\*See WD Catalog ORD 2 Index for published pamphlets of the Ordnance Supply Catalog.

*e. SIGHTING AND FIRE CONTROL EQUIPMENT.*

Binocular, M13; complete-----	ORD (*) SNL F-210.
Light, instrument, M34-----	ORD (*) SNL F-205.
Mount, telescope and panoramic, M25-----	ORD (*) SNL F-216.
Periscope, M6-----	ORD (*) SNL F-235.
Post, aiming, M1-----	ORD (*) SNL F-35.
Quadrant, gunner's, M1 (mils)-----	ORD (*) SNL F-140.
Set, lights, aiming post, M14-----	ORD (*) SNL F-205.
Setter, fuze, M23-----	ORD (*) SNL F-293.
Table, firing, graphical, M28 (FT 155-Q-1 or 2).	ORD (*) SNL F-237.
Telescope, panoramic, M12A6-----	ORD (*) SNL F-214.

**3. Other Publications**

*a. FUNDAMENTAL PRINCIPLES.*

Ammunition, general-----	TM 9-1900.
Ammunition inspection guide-----	TM 9-1904.
Artillery, ammunition-----	TM 9-1901.
Automotive electricity-----	TM 10-580.
Auxiliary fire-control instruments (field glasses, eyeglasses, telescopes and watches).	TM 9-575.
Ballistic data, performance of ammunition---	TM 9-1907.
Basic maintenance manual-----	TM 38-650.
Care and maintenance of ball and roller bearings.	TM 37-265.
Cooling systems: Vehicles and power ground equipment.	TM 9-2858.
Driver selection and training-----	TM 21-300.
Driver training, half-track and full-track vehicles.	TM 21-301.
Driver's manual-----	TM 21-305.
Electrical fundamentals-----	TM 1-455.
Elementary optics and applications to fire con- trol instruments.	TM 9-2601.
Fuels and carburetion-----	TM 10-550.
Graphical firing tables-----	TM 9-524.
Military motor vehicles-----	AR 850-15.
Motor vehicle inspections and preventive maintenance service.	TM 37-2810.
Ordnance service in the field-----	FM 9-5.
Precautions in handling gasoline-----	AR 850-20.
Qualifications in arms and ammunition, train- ing allowances.	AR 775-10.
Radio fundamentals-----	TM 11-455.

\*See W.D. Catalog ORD 2 Index for published pamphlets of the Ordnance Supply Catalog.

Radio operator-----	TM 11-454.
Range regulations for firing ammunition for training and target practice.	AR 750-10.
Service of the piece—155-mm. howitzer, M1--	FM 6-81.
Small arms ammunition-----	TM 9-1990.
Small arms, light field mortars and 20-mm. aircraft guns.	TM 9-2200.
Standard artillery and fire control instruments.	TM 9-2300.
Standard military motor vehicles-----	TM 9-2800.
Storage batteries—lead-acid type-----	TM 9-2857.
Targets, target material, and training course layouts.	TM 9-855.
Vehicular general purpose unit equipment----	TM 9-834.
155-mm. howitzer, M1-----	TM 9-331.
<b>b. MAINTENANCE AND REPAIR.</b>	
Cleaning, preserving, sealing, lubricating, and related materials issued for ordnance matériel.	TM 9-850.
Maintenance and care of pneumatic tires and rubber treads-----	TM 31-200.
Ordnance maintenance: Carburetors (Carter).	TM 9-1826A.
Ordnance maintenance: Differential, final drives, track suspension, hull and turret for light tank M24 and twin 40-mm. gun motor carriage M19.	TM 9-1729C.
Ordnance maintenance: Electrical equipment (Delco-Remy).	TM 9-1825A.
Ordnance maintenance: Engines, cooling systems, and fuel systems for light tanks M5, M5A1, and M24, 75-mm. howitzer motor carriage M8, and twin 40-mm. gun motor carriage M19.	TM 9-1729A.
Ordnance maintenance: Fire extinguishers--	TM 9-1799.
Ordnance maintenance: Fuel pumps-----	TM 9-1828A.
Ordnance maintenance: Light tank M24 and twin 40-mm. gun motor carriage M19—transmission, transfer unit, propeller shafts, controlled differential and final drives.	TM 9-1729B.
Ordnance maintenance: Speedometers, tachometers, and recorders.	TM 9-1829A.
<b>c. PROTECTION OF MATÉRIEL.</b>	
Camouflage-----	FM 5-20.

Camouflage of vehicles.....	FM 5-20B.
Camouflage of field artillery.....	FM 5-20D.
Chemical decontamination company.....	FM 3-70.
Decontamination.....	TM 3-220.
Decontamination of armored force vehicles..	FM 17-59.
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